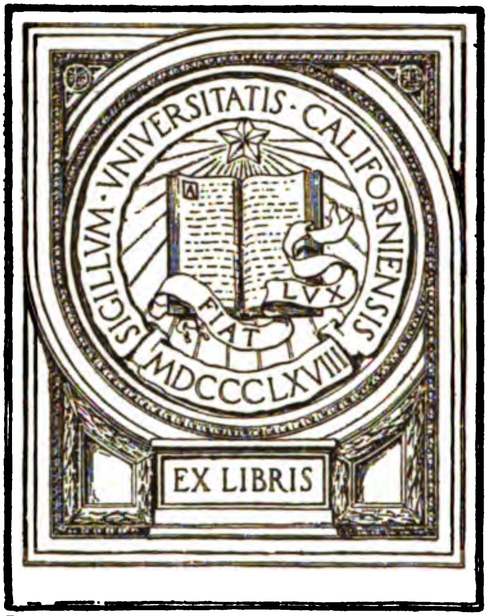
SAFETY ENGINEERING
APPLIED TO
SCAFFOLDS

THE TRAVELERS INSURANCE COMPANY
HARTFORD, CONNECTICUT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DECORATORS' SCAFFOLD IN GRAND CENTRAL TERMINAL STATION, NEW YORK CITY.
(The room is about 300 feet long, 120 feet wide, and 100 feet high. The side scaffolds were of the independent pole type, and the one under the ceiling was suspended by wire ropes. The whole job cost about $13,000.)

A TREATISE ON SAFETY ENGINEERING
AS APPLIED TO

SCAFFOLDS

THE TRAVELERS INSURANCE COMPANY
HARTFORD, CONNECTICUT

This book will be sent, postpaid
to any address, upon receipt of three dollars. Address
The Travelers Insurance Company,
Hartford, Connecticut

PREFACE

Scaffolds are employed widely and by many different classes of workmen; but as they are erected for temporary use only, they seldom receive the thoughtful consideration that is given to permanent structures. They are badly designed and badly built, as a rule, and all too often the materials that are used in them are poor in quality and deficient in size and quantity. In fact there appears to be a wide-spread and almost universal belief to the effect that a scaffold is not worth serious study; that anybody who can drive nails can build one that will serve; and that anything that may happen to be at hand is good enough to go into it. The result is, that bricklaying, carpenter work, painting, decorating, and many other operations in which men must work at some considerable height, and life and limb are constantly at stake, are often performed by the aid of scaffolds that are distinctly dangerous, and altogether unfit for the purpose for which they were intended.

The very fact that scaffolds must be erected is sometimes entirely overlooked in making bids for building operations and other extensive work of a similar nature, and it is by no means uncommon for a sub-contractor to make no provision of his own for the materials for his scaffolds, but to rely upon picking up something about the job that will serve his purpose.

These remarks are not inspired by mere pessimism. They are plain uncolored statements of facts

that any interested person can verify for himself without the least trouble, and which have become as familiar to The Travelers Insurance Company, in the course of its long and extensive experience in compensation insurance, as the alphabet or the multiplication table. To see the results of this state of things it is only necessary to watch the newspapers, which are continually reporting deaths or injuries, through the failure of scaffolds as a whole or in some of their parts, or through the falling of men because of inadequate protection or no protection at all, or through the downfall of tools or materials from high places, upon workmen below, or upon persons passing by.

It would be absurd to say that scaffolds are *universally* bad, because quite a fair proportion of them (an *increasing* proportion, we believe) would certainly be pronounced reasonably safe. Yet the conditions that we have outlined above are common enough to make it highly desirable to call attention to them, and to urge that such methods be discontinued, and that safer and more rational ones be substituted. Scaffolds are important structures, and they should be erected and supervised by men who understand this kind of work thoroughly well. The materials used should be first-class in quality and abundant in quantity, and every part should be strong enough to sustain any stress that may be thrown upon it, without any uncertainty whatsoever.

It is impossible to understand why the general subject of scaffolding has not been more fully discussed in the standard treatises on building and other arts allied thereto. It is true that there are one or two American books which treat of scaffold problems, but

they deal mainly with special scaffolds which are but little used, and moreover they are almost exclusively concerned with the *efficiency* of the workman, and touch upon the question of *safety* only briefly and incidentally. With these exceptions it is almost impossible, in the whole range of American technical literature, to obtain detailed information respecting the proper construction of scaffolds, or the dangers that are involved in their use, or the means that it is advisable to employ, to reduce these dangers to a minimum.

The Building Trades Associations of Germany issue small pamphlets in which the most essential points are covered, and the subject is also considered to a very limited extent in a few of the English books (as for instance in Mitchell's "*Building Construction: Advanced Course*"). Thatcher's little book is the only one we know of, that is devoted exclusively to scaffolding. It is excellent so far as it goes, but it represents English practice only; and as American practice differs in many respects from the practice of Europe, foreign publications are necessarily of minor interest and importance in this country. Suspended scaffolds for construction work, for example, such as are discussed in Section X of the present volume, are distinctively American, and are practically unknown in other countries.

The paucity of information here noted in connection with books, characterizes our various engineering periodicals also; for while these give occasional articles descriptive of newly-designed scaffolds or scaffolds that have a "news" interest for some other reason, they contain nothing respecting the commoner forms and their dangers.

It might be thought that the building codes of our larger cities, inasmuch as they contain minute requirements on many points of construction, would also include specifications with regard to scaffolds; but an examination of these codes shows that they either disregard scaffolds altogether, or treat them inadequately and superficially.

To remedy this state of things, the Engineering Division of THE TRAVELERS INSURANCE COMPANY has prepared the present work, in which various forms of scaffolding that are commonly met with in American practice are illustrated and described. We have treated the entire subject from the standpoint of *safety*, and we are confident that if builders and others will attend to the points that are discussed herein, there will be a great reduction in the number of deaths and injuries that now attend scaffold work.

We believe that our suggestions are reasonable in all cases. In addition to the things that appear to be absolutely essential, we have called attention to many others that can be done with advantage; but we believe that we have nowhere been too exacting, and we are satisfied that the points upon which we have laid special stress will be admitted to be of prime importance, by all who have given thoughtful attention to the subject.

The unsatisfactory state of the art of scaffolding in this country is well shown by the difficulty of obtaining illustrative photographs that are satisfactory in all respects. A scaffold that shows excellent bracing may have no guard-rails, and one that shows fine, large, straight poles may have weak ledgers. In examining the engravings that we give, this difficulty

should be borne in mind. Illustrations could have been "prepared", in which all conditions would have been ideal; but it was thought best to give views taken from real scaffolds, under actual working conditions.

It is impossible, without greatly increasing the size of the book, to mention every feature that tends to promote safety, at every point where it may apply. For example, the principle of overhead protection of men on a suspended scaffold applies also to the bricklayers' pole scaffold when the work happens to be done where similar hazards exist. This should be understood, even though it is not explicitly mentioned; and the same principle should be applied throughout the book. In fact, the various suggestions that the book contains should be combined in whatever way the conditions that have to be met may suggest.

To avoid misunderstanding, and to forestall any criticism that might be made because we have not dwelt upon all forms of builders' scaffolds at a length corresponding with their relative importance in the engineering world, let us point out that the discussion of each separate design with the same fullness would involve a great deal of unnecessary repetition, would prove confusing to the reader, and would extend this volume to such dimensions that its usefulness would be greatly impaired. We have no thought of giving undue prominence to any special form of scaffold, whatsoever, because we stand only for safety; and so long as this is assured beyond question, we do not care what particular type of construction is adopted. The special forms that we describe have been chosen merely as illustrative of the principles that are involved, and it has not appeared necessary or desirable to multiply

the illustrations further. It should be borne in mind, throughout, that this work is designed to be merely a treatise upon *safety engineering* as applied to scaffold work, and that it does not pretend to be encyclopedic.

In conclusion we beg to say that the book is based mainly upon the results of THE TRAVELERS INSURANCE COMPANY'S own experience and observation, obtained in the course of its regular work of inspection and research, though we desire to acknowledge our indebtedness to Mr. A. E. Davidson of the Chesebro-Whitman Company for suggestions on certain points, and especially for some of the data in paragraph 57. The inspection service of THE TRAVELERS has grown to be enormous, and its staff includes men who are experts in every important line of human industry. A vast fund of information has been accumulated in this way, respecting the conditions that must be fulfilled in order to insure safety in industrial operations of all kinds, and we are giving the results of our experience to the general public in a series of publications of this same general nature, dealing with various phases of the safety problem. We can hardly doubt that this course will lead to a material improvement in existing standards of construction and operation along the many lines with which we shall deal; and if this end is accomplished, and a saving of life and limb results, our hopes will be realized and we shall be well repaid.

THE TRAVELERS INSURANCE COMPANY,

Hartford, Connecticut.

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ILLUSTRATIONS.

(The numbers of the illustiations are given on the left, and the page numbers on the right.)

SCAFFOLDS

I. REALITY OF THE SCAFFOLD HAZARD.

1. Few Statistics Available. Scaffolds having hitherto received so little attention, it appears desirable to open our discussion of them by giving data that will show, beyond question, the great need of improvement in their construction and use. Statistics of scaffold accidents are hard to obtain, however, and the figures that are available are exceedingly meager. The United States Census Bureau, at Washington, can furnish no data on the subject, nor can the various individual states of the Union, except in a few cases. This is not because the accidents are rare, but because they are either not reported to the authorities, or not classified so that they can be abstracted readily. Inquiries that we have made in all the cities of the United States having a population of 100,000 or more, show that few of them can furnish data respecting the number of deaths from scaffold accidents, without a laborious and impracticable search through coroners' records. A number of these cities classify their deaths by the Bertillon or International method, which is entirely sufficient for most purposes; but while scaffold accidents are occasionally recorded specifically under this system, they usually have no definite place in it,

but are distributed under such general heads as "Fractures", "Falls", "Accidental Traumatisms", and the like.

This being the situation with regard to fatal accidents, it is not surprising to find that the available statistics of non-fatal ones are mostly so incomplete and fragmentary that to print any of them would be actually misleading. The accidents that occur in factories, foundries, mines, and other such localized centers of industrial activity, are often recorded quite fully by the State authorities, but those that occur in connection with construction work are seldom noted in the same systematic way.

2. Concerning Newspaper Items. Since full and authoritative statistics of scaffold accidents cannot be had, a few newspaper items, gathered in 1911, are given below, in the hope of conveying a more or less definite idea of the general nature of accidents of this kind, and of the loss of life and the number of personal injuries that they commonly involve. These items probably represent but a small fraction of the entire number of scaffold accidents that occurred during the period covered, and it would therefore be unjustifiable to draw any definite conclusions from them, with respect to the total number of similar accidents that occur in the United States in one year, or in any other stated interval of time.

It should be understood that we do not guarantee the literal accuracy of all these accounts, because we have no knowledge of the facts (save in a few cases), except as they are given in the clippings themselves. We print the accounts in good faith, however, and we believe them to be correct in all essential particulars.

3. Illustrative List of Scaffold Accidents.

1. June 6th. Part of the scaffold surrounding the new theater at Paxtang Park, Harrisburg, Pennsylvania, collapsed. One man fell 39 feet. His right leg and ankle were broken.

2. June 8th. A man fell from a scaffold used in the construction of a building on Bruce and Inness avenues, Cincinnati, Ohio. He was badly injured.

3. June 9th. A scaffold broke at the plant of the Astoria Heat, Light & Power Company, at Casino Beach, near Astoria, New York. Two men were injured.

4. June 9th. A scaffold fell at a building on

FIG. 1. SAFETY SCAFFOLDING.

(From a full-sized model, exhibited at the Leipzig Exposition of 1913. Fig. 2 shows the same building, as seen from the opposite side.)

East Jackson Boulevard and South Michigan avenue, Chicago. A man who was working upon it was thrown to the pavement and badly injured.

5. June 9th. Three men fell from a scaffold at 214 Lake avenue, Rochester, New York. All three were more or less injured.

6. June 9th. A scaffold rope broke at the Meise store, Vincennes, Indiana. One man, a painter, was killed.

7. June 10th. A man was injured by falling 28 feet from a scaffold at the new power house at Mt. Tabor, near Newark, New Jersey.

8. June 12th. A scaffold rope broke on a swinging scaffold at the new building at 28 West 23d street, New York. Four iron-workers were on the platform of the scaffold and they were all striving to bring a huge steel beam into place. The rope that broke was thereby subjected to great strain. The four men fell two stories but none of them were dangerously injured.

9. June 12th. A scaffold collapsed on the first floor of the post-office building, Philadelphia, Pennsylvania. A fresco painter who was working upon the scaffold fell 20 feet and was injured.

10. June 12th. A scaffold fell near Milverton, Ontario. Three men were seriously injured.

11. June 14th. Two men fell from a scaffold at the Metropolitan Museum of Art, New York City. One was killed and the other was seriously injured.

12. June 15th. A carpenter fell from a scaffold at the Good Samaritan Hospital at Clifton, near Cincinnati, Ohio. He died two weeks later.

13. June 16th. A rope broke on a scaffold inside the rotunda of the People's Gas Light and Coke Building, Chicago, Illinois. One man was killed and another fatally injured. The men were engaged in washing the walls of the rotunda.

14. June 16th. A scaffold fell near New York City. Two men were injured.

15. June 16th. A scaffold gave way at the People's Church, East Lansing, Michigan. One man was injured.

16. June 16th. A man was injured seriously and perhaps fatally by falling from a scaffold at St. Stephen's Catholic church, Geneva, New York. He stepped on the end of a plank, which tipped up under his weight and caused him to fall 30 feet.

17. June 16th. An extension ladder which was being used as a scaffold at the Grice Building, Norfolk, Virginia, broke short off. A painter who was standing upon it was thrown to the pavement below and received injuries from which he died.

18. June 17th. A scaffold gave way at the Atlantic Coast Line station, Fayetteville, North Carolina. It was used in repairing the roof of the building. Two slaters fell a distance of 25 feet and were injured.

19. June 17th. A man fell from a scaffold built around an oil tank at Claymont, near Wilmington, Delaware. He was seriously injured.

20. June 17th. A carpenter was injured by falling from a scaffold at Twin Oaks, near Chester, Pennsylvania. He stepped on a loose board and was thrown to the ground.

21. June 19th. A scaffold gave way at Davenport, near Marshalltown, Iowa. Two men were injured.

22. June 19th. A scaffold collapsed at Elliott avenue and Murray street, Yonkers, New York. Four men were injured, and it was believed that two of them could not recover.

23. June 21st. A man was seriously injured by falling from a scaffold on Johnstone avenue, Cohoes, New York.

24. June 21st. Two men were badly injured by falling from a scaffold on Midvale avenue, Roxboro, Philadelphia, Pennsylvania.

25. June 23d. A scaffold collapsed at Utica, New York, and two men were injured by falling to the ground.

26. June 24th. A carpenter was injured by falling from a scaffold at Baltimore, Maryland.

27. June 26th. A man was seriously injured by falling from a scaffold on Woodward street, Jersey City, New Jersey.

28. June 27th. A scaffold collapsed at Yonkers, New York. Two carpenters were thrown to the ground and injured,—one of them fatally.

29. June 27th. A scaffold gave way at Detroit, Michigan. Three men were thrown to the ground and injured.

30. June 27th. A scaffold collapsed in Dry Dock No. 4, at the Navy Yard, Brooklyn, New York. One man was badly injured.

31. June 27th. A scaffold gave way at Lebanon, near Albany, New York. One man was seriously injured.

32. June 30th. The ropes supporting a swinging scaffold gave way at the State School for the Deaf and Blind, Ogden, Utah. Two painters who were

at work upon it were thrown fifty feet to the ground. One of them was killed instantly, and the other was injured seriously and perhaps fatally.

33. June 30th. A scaffold gave way on Elizabeth street, Utica, New York. Two men were injured.

34. July 1st. A scaffold collapsed in a sewer at Sioux City, Iowa. One man was injured. It is reported that the material used in the scaffold was imperfect.

FIG. 2. SAFETY SCAFFOLDING.
(From a full-sized model, exhibited at the Leipzig Exposition of 1913.)
(Compare Fig. 1.)

35. July 1st. A scaffold gave way at the annex to the Novelty Works, Duncannon, Pennsylvania. One man was injured.

36. July 3d. A painter was killed by falling from a scaffold at the Richards Hotel, McKeesport, Pennsylvania.

37. July 3d. A man was killed by falling from a scaffold at Washington and Barrow streets, New York. The scaffold was suspended by ropes, and the man who was injured pushed it away from the wall and fell through the opening so made.

38. July 5th. A scaffold gave way at Fifteenth street and Madison avenue, Cincinnati, Ohio. A carpenter who was working upon it was injured.

39. July 5th. Two men were injured by the fall of a scaffold at the New Dort School, Flint, Michigan. The accident was due to the breaking of the ropes by which the scaffold was supported. It is said that they had become rotted by the action of acid used by painters in their work.

40. July 6th. A scaffold fell on Vanderbilt street, Brooklyn, New York. Two men were injured.

41. July 7th. A painter fell from a swinging scaffold at Newark, New Jersey, and was badly injured.

42. July 7th. A scaffold collapsed at East 129th street and Bartfield avenue, Cleveland, Ohio. One man was severely injured.

43. July 7th. A man was killed by falling from a scaffold at Coffeyville, Kansas.

44. July 7th. A painter was fatally injured by falling from a scaffold at 415 North Seventh street, St. Louis, Missouri.

45. July 8th. A man was seriously injured, at McKeesport, Pennsylvania, by the fall of a scaffold that was used in tearing down a building.

46. July 11th. A scaffold fell at the New York Military Academy, Cornwall, New York. One man was seriously injured.

47. July 11th. Five men were injured at Englewood, New Jersey, by the breaking of one of the supports of a scaffold at the new Church of St. Cecilia.

48. July 11th. A carpenter was overcome by heat while working on a scaffold at Kalamazoo, Michigan. He fell to the ground and was fatally injured.

49. July 11th. A man was fatally injured by falling from a scaffold at Galesburg, Michigan.

50. July 12th. A man was seriously injured by falling from a scaffold at Dunstable, near Nashua, New Hampshire.

51. July 13th. A man was fatally injured by falling from a scaffold at the new High School, at Redford, Indiana.

52. July 13th. A scaffold collapsed at No. 2 Elevator, Montreal, Quebec. Seven men were injured.

53. July 18th. A scaffold fell at Gary, Indiana. One man was killed and three others were injured.

54. July 18th. A man was seriously injured by falling from a scaffold in West Broadway, New York City.

55. July 18th. A carpenter was fatally injured by falling from a scaffold at Vancouver, British Columbia.

56. July 19th. A man was injured by falling from a scaffold at Cincinnati, Ohio.

57. July 20th. A scaffold collapsed at Raleigh, near Hamilton, Canada. Two men were critically injured.

58. July 20th. A scaffold, used in repairing a building, collapsed at Covington, Kentucky. One man was injured.

59. July 21st. A rope broke on a hanging scaffold at 210 Washington street, Hoboken, New Jersey. The scaffold fell, killing one man and injuring two others.

60. July 21st. A swinging scaffold used for painting the Arcade Building, Toledo, Ohio, tipped and threw a painter to the ground. He was badly injured.

61. July 24th. A painter was seriously injured at Gloversville, New York, by the fall of a scaffold. Some of the wooden parts of the rigging broke, and the entire structure crashed to the ground.

62. July 25th. A man fell from a scaffold at the Caldwell Lawn Mower Works, Newburgh, New York. He was critically injured.

63. July 25th. A scaffold fell in the yards of the New York Central railroad, near Syracuse, New York. One man was injured.

64. July 26th. A scaffold gave way on Maple street, Jersey City, New Jersey. A carpenter was badly injured.

65. July 27th. A painter was killed by falling from a scaffold on Lafayette avenue, Brooklyn, New York.

66. July 27th. A carpenter was badly injured by falling from a scaffold at Cleveland, Ohio.

67. July 27th. A painter was seriously injured by falling from a suspended scaffold in the South Bergen district of Jersey City Heights, New Jersey.

68. July 27th. A man was fatally injured by falling from a scaffold at Rochester, New York.

69. July 27th. A carpenter was fatally injured by falling from a scaffold at the Baptist Church, Nicholasville, Kentucky.

70. July 31st. Three men were injured by the fall of a scaffold at Philadelphia, Pennsylvania. A considerable amount of brick and mortar fell upon the scaffold and wrecked it.

71. July 31st. A painter was killed by falling from a scaffold in Brooklyn, New York.

72. July 31st. A scaffold fell on Park avenue, Indianapolis, Indiana. A tinner was thrown to the ground and seriously injured.

73. July 31st. A carpenter was severely injured by the fall of a scaffold at the foot of South street, Milwaukee, Wisconsin.

74. July 31st. Two painters were seriously injured, at Sparta, Wisconsin, by the breaking of a tackle scaffolding.

75. August 1st. Two men were injured at 524 Cortland street, West Hoboken, New Jersey, by the falling of a scaffold used in shingling a roof. The accident was said to be due to the loosening of one of the brackets.

76. August 2d. A painter was severely injured by falling from a scaffold in Jersey City Heights, New Jersey. He inadvertently stepped off the scaffold backward.

77. August 2d. A painter was killed by falling from a scaffold at the Albany Hotel, Denver, Colorado.

78. August 4th. A man was painting the smokestack of the Stearns Automobile Company, when

a knot slipped in one of the ropes which supported the scaffold on which he was working. The scaffold fell and the man was seriously injured.

79. August 5th. A man was killed by falling from a scaffold at Cincinnati, Ohio.

80. August 7th. A man was fatally injured by falling from a scaffold at Rochester, New York.

81. August 9th. A scaffold gave way at Houston, Texas. A carpenter was seriously injured.

82. August 10th. A man was seriously injured by falling from a scaffold on Front avenue, Cleveland, Ohio.

83. August 12th. A scaffold gave way at the Co-operative Foundry in Lincoln's Park, Rochester, New York. One man was fatally injured.

84. August 14th. A man was fatally injured by falling from a scaffold at Second and Church streets, Philadelphia, Pennsylvania.

85. August 15th. A scaffold gave way on the roof of the Reformed Church, Ellwood, Pennsylvania. Two tinners slid to the edge of the roof and then plunged to the ground. One of them was killed and the other injured.

86. August 17th. A carpenter was seriously injured by falling from a scaffold at Rochester, New York.

87. August 17th. A scaffold fell at a Jewish church in course of construction in Chicago, Illinois. Three men were injured, one of them fatally.

88. August 17th. A scaffold gave way on Augustine street, Rochester, New York. Two men were injured, one of them fatally.

89. August 18th. Two men were seriously injured by falling from a scaffold under the skylight of

the Sackett School, Cleveland, Ohio. A plank broke while the men were standing on it.

90. August 18th. A scaffold fell in the new Lakewood Theater, Cleveland, Ohio. Four men were injured.

91. August 23d. Two masons were seriously

FIG. 3. MISCELLANEOUS SCAFFOLDS: GERMAN PRACTICE.

(From a model, constructed about one-tenth actual size. Other views of this model are given in Figs. 4 and 7.)

hurt by the fall of a scaffold at the new Sunday School Building, on East Dauphin street, Philadelphia, Pennsylvania. The accident was apparently due to the overloading of the platform of the scaffold with blocks of granite.

92. August 24th. A painter was injured by falling from a scaffold on Canal street, Lyons, New York.

4. Comments on the Foregoing List. It will be noted that in something like forty per cent. of the accidents reported above, men fell from the scaffold while the structure itself remained undisturbed so far as can be judged from the information that is given. It is probable that in the majority of these cases the accidents would not have occurred if suitable hand-rails and other protective devices had been provided and the platform planks or boards had been properly laid. It is fair, therefore, to count these many preventable cases of simple falls as accidents due to defects in the scaffolds,—because an error in design is a defect, just as surely as is a flaw in the actual physical material.

It is worthy of remark that the foregoing list, which is based upon newspaper items covering the 92 days of June, July, and August, happens to contain accounts of exactly 92 scaffold accidents,—which corresponds to an average of precisely one accident per day. Moreover, these 92 accidents resulted in the deaths of 31 persons, and in more or less serious injuries to 115 others. The experience and observation of The Travelers Insurance Company, extending over many years, indicates that the scaffold accidents by which men are killed or injured in the United States would be found to far exceed one a day, if they could all be included; and in view of this fact, and of the

further fact, already noted, that scaffolding has practically no literature at the present time, it was thought best to devote one entire volume of THE TRAVELERS' series to it, as a contribution toward the establishment of a standard approved practice, in the interest of increased safety.

II. SCAFFOLDS CONSIDERED GENERALLY.

5. Forms and Uses of Scaffolds. Scaffolds and stagings are built in many different forms, according to the purposes they are to serve. They are used in new building construction, in repair work on old buildings, in riveting, in building chimneys, in pointing brick-work, in cleaning walls, in plastering, painting, paper hanging and decorating, and in various other operations which need not be enumerated. In some of these applications (as, for example, in plastering or painting rooms of ordinary height) the workmen are elevated only four or five feet. A fall from this height often results in painful injuries but it rarely results in death, and in the majority of cases the men escape entirely without harm. In many other cases, however, the men have to work at a considerable height above the ground, or above the nearest floor to which they might fall in the event of an accident; and we shall give the major part of our attention to the forms of scaffold that are used for work of this more hazardous nature, where a fall is almost certain to be accompanied either by death or by personal injuries of the most serious nature.

6. Scaffolds for Building. These include the forms used by bricklayers, masons, carpenters, and certain other classes of artisans. The types that are used chiefly by bricklayers and masons will receive particularly full treatment, because nearly all of our modern high buildings are built of brick or stone, or

(more recently) of concrete, and carpenters' stagings are employed mainly upon lower buildings and for auxiliary operations such as roofing and inside finishing.

The scaffolds that are used in building operations by bricklayers and masons may be divided into three main classes, which may be designated, according to their respective natures, as "pole scaffolds", "suspended scaffolds", and "outrigger scaffolds".

7. Pole Scaffolds. Of the three main types just enumerated, the "pole scaffold" is by far the commonest. It is so named because its weight is supported, either wholly or in part, by poles or uprights that rest upon the ground, or upon a sill or some other foundation that itself rests upon the ground. Scaffolds of this type are also called "fixed scaffolds", from the fact that they remain in place until the wall that is to be erected is completed; but the name "pole scaffold" is preferable, because it is more precise and descriptive. Pole scaffolds are not adjustable in any way, and they are changed, as the work proceeds, only by building on to them above, so as to extend them upward, or by shifting the platforms upon which the men work, by removing the planking from one level and relaying it anew at a higher one. The most essential characteristic of the pole scaffold is that its weight is supported by a thrust or *pressure* upon the poles or upon the wall that is being built, and never by a *tension* upon cables or other similar or equivalent devices.

The pole scaffold is fairly uniform in design throughout the United States, and the forms that are used here differ chiefly in matters of detail from those that are employed in Europe for similar purposes. In this country, for example, the parts of the scaffold are

fastened to one another mainly by nailing, and they are made of sawed lumber almost exclusively; but in England and in continental Europe the parts are held together largely by clamps or ropes, and a considerable use is made of round wood, this consisting of the original

FIG. 4. MISCELLANEOUS SCAFFOLDS: GERMAN PRACTICE.
(From a model, constructed about one-tenth actual size. Compare Figs. 3 and 7.)

sticks, perhaps shaved down a little, but substantially of the size to which they grew, and with their fibers practically uncut.

Scaffolds that are used for laying stone should be more strongly built than those used for laying brick, because they are likely to be loaded more heavily. The difference in the loading is less marked in the United States than it is in some foreign countries, because here the stone that is to be laid is usually delivered ready for immediate use, whereas in England, for example, it is often deposited upon the scaffold while there is still a considerable amount of work to be done to it in the way of trimming or fitting or other preparation. In American practice the stone is commonly hoisted directly to its final position, without having its weight thrown upon the scaffold at all; and in fact the scaffold upon which the stone masons stand is usually inside of the wall that is going up, while the stone is hoisted on the outside. Yet scaffolds for laying stone are also used more or less, in the United States, in such a way that there is likelihood of their serving to some extent as temporary storage places for some of the stone; and in every case of this kind special care should be taken to have all of the parts of the scaffold particularly stout and strong. (See paragraph 57, page 90.)

The independent pole scaffold is distinguished from what is known as the bricklayers' pole scaffold not only by its greater strength, but also by one conspicuous and noteworthy structural detail. In laying a brick wall by the aid of a pole scaffold it is usual to utilize the wall itself for supporting the inner edge of the working platform, so that in this type there is

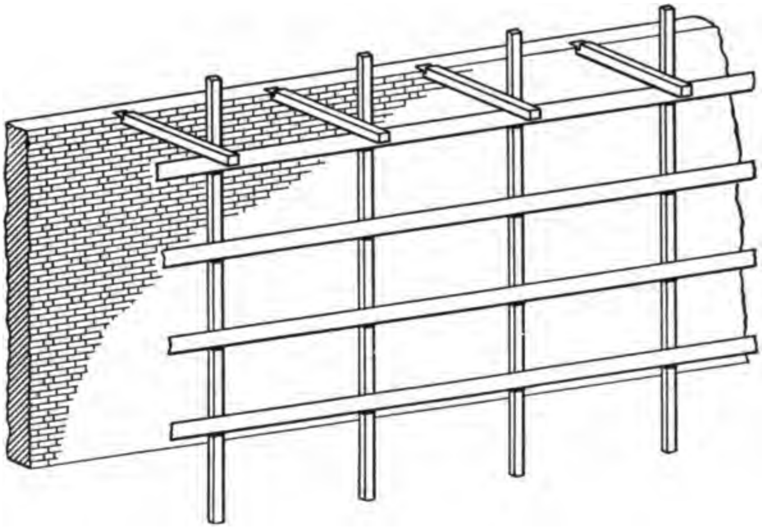

FIG. 5. SKELETON OF A BRICKLAYERS' POLE SCAFFOLD.
(Platform, braces, guard-rails, and foot-boards omitted.)

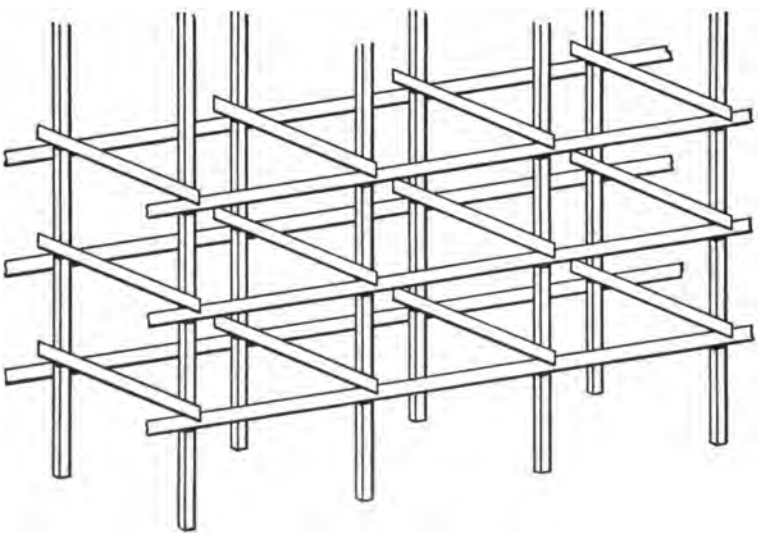

FIG. 6. SKELETON OF AN INDEPENDENT POLE SCAFFOLD.
(Platform, braces, guard-rails, and foot-boards omitted.)

but one row of uprights. On the other hand, in building with stone it is not customary to depend upon the wall for sustaining any part of the weight of the scaffold, the support afforded by the wall when building with brick being obtained by providing a second row of poles, set close to the stonework.

The scaffold with two rows of poles is self-sustaining (in the sense that it is independent of the wall), and for that reason we shall call it the "independent" scaffold throughout the present work.

It should not be understood that the bricklayers' scaffold is used solely for laying brick, nor that the independent scaffold is used solely for laying stone. It is convenient to retain the names that custom has attached to them, so that either type of scaffold may be quickly and simply designated; but the independent type with its two rows of supporting poles can be applied equally well to the building of brick walls, and an unmistakable and increasing tendency to use it in this way has in fact been noticeable in the last few years. It is also commonly adopted in repair work and for other purposes, in connection with walls that are already built and which have no openings, or an insufficient number of conveniently-situated openings, for receiving the ends of the cross-beams or putlogs that support the platform in the bricklayers' type.

8. Suspended Scaffolds. The pole scaffolds, just considered, are used quite widely in the erection of buildings that are not more than five stories high or thereabouts, and upon higher ones when they have no framework of structural steel. Modern builders greatly favor the steel framework for buildings of more than five stories or so, however, and when it is adopted some

form of swinging scaffold can be used by the bricklayers with advantage. In putting up a steel-framed building with the aid of such a scaffold the steelwork is carried up to a considerable distance before the laying of brick begins, and when the frame has reached a suitable height the scaffold is installed. It consists essentially of a platform swung from the upper part of the steel framework by means of steel cables, or steel straps, and so designed and arranged that the level of the platform can be conveniently raised as the work progresses. When cables are used, the platform is usually shifted by means of windlasses that wind up the cables, and when the support is afforded by steel straps these are perforated at intervals, so that the cross-beams or putlogs supporting the platform can be raised from time to time, and shifted to new positions.

The mechanism by which the platform is shifted varies somewhat in the different makes of scaffold, and in a later division of this work two or three of the standard forms of it are described in some detail. The types of scaffold in which the platform is supported by flexible cables are far more commonly met with, at the present day, than those in which steel straps are employed.

Advocates of the swinging scaffold assert that it is far safer than the pole type for use on high buildings, and this claim is undoubtedly justifiable when the scaffold is in good condition and is properly installed and handled. A pole scaffold is practically out of the question, in fact, for use on an American "sky-scraper," because it would have to be exceedingly substantial and massive to be safe against collapse from its own weight and its load of materials and the side stresses

due to the wind and other causes, and its cost would also be prohibitive.

9. Outrigger Scaffolds. In the "outrigger" scaffold the platform is supported upon beams or outriggers (which are also known as "cantilevers", or "thrust-outs", and by various other names), which extend out through windows or other openings in the walls, and which are secured solidly to the framework or flooring, inside of the building. Outriggers are used also in connection with suspended scaffolds, but the distinction between the suspended scaffold and the "outrigger type" consists in the fact that in the suspended scaffold the platform is *hung* from the outriggers, while in the outrigger type the platform rests upon the outriggers either directly or by the mediation of some simple structure designed to raise the platform to a somewhat more convenient height.

In building operations outrigger scaffolds are used somewhat (though fortunately, as we believe, to a diminishing extent) for the support of one or more layers of horses, upon which planks are laid for sustaining the workmen. Outrigger scaffolds, when used, must be carefully designed and secured, and it is preferable to make use of some other form when this can be done without prohibitive expense or difficulty.

10. Construction Practice in General. In England a scaffold is usually built only on one side of a brick wall, if the wall is 9 inches thick, but for all brick walls of a greater thickness, and for walls built of stone, it is usual to erect a scaffold on both sides. In the United States the practice is so varied that no general statement of this sort can be made. In some parts of the country the bricklaying, when the building is not too large,

is done mainly or altogether from the inside. This is called "overhand laying" and it has the advantage that no scaffold is required, the work of the bricklayers being done from horses that stand upon the floors, inside,—the floors being laid as the walls go up. The overhand method, on the other hand, is regarded with disfavor by many builders, on the ground that it is hard to make a good-looking wall in this way, because in finishing the outside surface the men have to lean over "soft" courses of brick, and work at a disadvantage.

In the United States it is becoming increasingly common to expedite the bricklaying by building from both sides of the wall at once, the inner courses of brick being laid from the floors by the aid of horses, while the outer courses are laid from the outside by means of a suspended scaffold, hung from the steel skeleton of the building as already described.

11. Carpenters' Outside Stagings. Carpenters' stagings, as applied in building wooden houses, are usually supported by brackets from the woodwork of the building itself. Those used for shingling are sometimes supported by brackets made to conform with the slope of the roof, and sometimes they consist merely of stringers laid along the roof horizontally, and made fast to it.

12. Painters' Outside Stagings. Painters' stagings, when used for outside work, commonly consist of narrow platforms, suspended by means of ropes hanging from hooks secured to the building above, or by some other equivalent means. The boatswain's chair, consisting of a seat of some kind suspended by a rope, is often used for light work.

13. Plasterers' and Decorators' Inside Stagings. In finishing the interior of a building, carpenters,

plasterers, and decorators make use of stagings which, although they are built in various forms, are nevertheless reducible to a few general types. One of the most important of these is similar in general nature to the independent pole scaffold mentioned above, it being supported by uprights resting upon the floor, cross-pieces being secured to these for sustaining the plank platforms upon which the workers stand.

14. Ladder Scaffolds. For certain kinds of work use is sometimes made of ladder scaffolds, in which the platform is supported from the rungs of specially-constructed ladders that are placed in vertical or nearly vertical positions, and supported in some safe manner.* Horizontally-placed ladders are also used to a considerable extent in light scaffold work, to support the boards upon which the men stand.

15. Small Hanging Stagings. For small work about buildings, as in repairing or in attending to small detail work where no great weight is to be sustained, it is common to throw out from the windows of a building a hanging staging, which is supported from firmly secured horizontal beams or outriggers, passing out from the windows perpendicularly to the wall of the building. These differ from the builders' suspended scaffolds described above in being of a far lighter type of construction, and they also differ from them widely in their structural details.

16. Chimney Stagings. In the construction of factory chimneys it is customary to build a staging circularly around the chimney, at least near its base, and sometimes to its entire height. A second one is usually built inside the chimney also. These stagings

*Scaffolds of this nature are extensively employed in Germany, and a further description of them will be found in paragraph 69, page 123.

frequently run up to great elevations, and they must be made correspondingly secure. For making local repairs a hanging staging is sometimes suspended from the top of the chimney, and swung down to the place where the work is to be done.

17. Other Forms of Scaffolds. Various other forms of scaffolds, which we cannot fully enumerate, are used in addition to those mentioned above. Among these, for example, are the stagings that are employed for the support of hoisting devices and the like, these being erected either outside of the building that

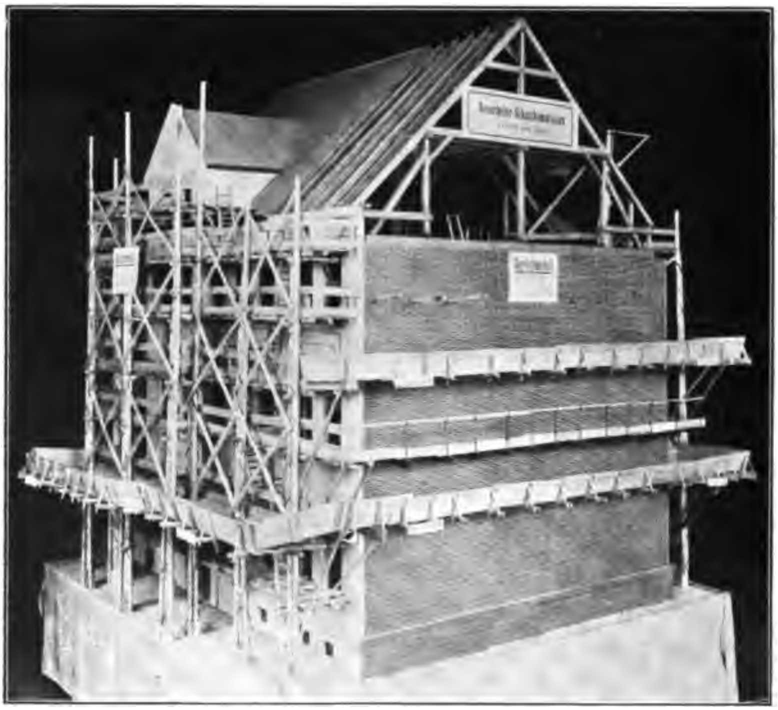

FIG. 7. MISCELLANEOUS SCAFFOLDS: GERMAN PRACTICE.
(From a model, constructed about one-tenth actual size. Compare Figs. 3 and 4.)

is going up, or inside of it,—the object of such a staging being to elevate the hoisting machine, or the sheaves over which its ropes run, sufficiently to insure convenience and facility in the delivery of the materials to the workmen. The latticed towers that are coming into general use in connection with concrete work are examples of this type.

18. Structures Similar to Scaffolds. False Work. There are many structures which are not true scaffolds, but which may nevertheless be classed with them, since they involve similar elements of design, and are subject to somewhat similar dangers in their operation. Examples of these are afforded by the false centers of arches, and by the supports that are provided for concrete superstructures, these being of a temporary nature, and designed to be taken down when the material has become sufficiently hard.

III. THE BRICKLAYERS' POLE SCAFFOLD: AMERICAN PRACTICE.

19. General Description. In the standard (or typical) bricklayers' scaffold, as built and used in the United States in the construction of brick walls, the platform upon which the workmen stand is supported by horizontal cross-pieces that are properly called putlogs, but which are also known, colloquially, as "putlocks" or "puds", and sometimes as "spuds". These run perpendicularly to the wall of the building, and each is supported at one end by the wall that is being erected, a brick being omitted from the face course for this purpose, so that the end of the putlog may enter the wall and have a proper bearing.

The outer ends of the putlogs rest upon horizontal stringers called "ledgers", or "running strips", which run parallel to the wall of the building, and are nailed to uprights or poles resting solidly upon the ground.

The bricklayers' scaffold, as thus constructed, is sometimes called the "Boston scaffold". Its general characteristics are shown in Fig. 8, and we proceed to consider its various parts in detail.

THE POLES OR UPRIGHTS

20. Material, Quality, and Size. In England the poles or uprights are usually made of fir and are round in form, being about five inches in diameter and some thirty feet long; but in the United States sawed spruce

is commonly used for the poles, and it is the best of the woods that are available for the purpose. Hemlock should never be employed, because it is brittle, and is likely to break suddenly, under a heavy load, with no warning.

The poles should be straight, and they should also be straight-grained and free from bad knots and all other imperfections. Twisted (or "winding") pieces should not be used for poles, because the ledgers and braces that are required in the construction of the scaffold cannot be nailed to such poles properly.

In erecting the poles, care should be taken to have them as nearly plumb (or vertical) as possible. This is particularly important, because any serious departure from the truly vertical position imperils the stability of the whole scaffold.

For ordinary work, where the wall to be built is not more than four or five stories in height and the platform of the scaffold is not loaded with more than the usual weight, the uprights, if of sound spruce wood as specified above, may be as small as four inches square. They are quite commonly made of stock measuring 3 in. by 4 in., but we strongly recommend the adoption of four inches as the least dimension in ordinary work.

21. Poles of Extra Strength. For higher buildings, and for use upon work where the platform is likely to be loaded more heavily than usual, the size of the poles should be correspondingly increased. In fact, it is often well to make the poles of two or even three parts, when the load is heavy or the structure is uncommonly high, the constituent parts being placed side by side, and securely bolted, clamped, nailed, or

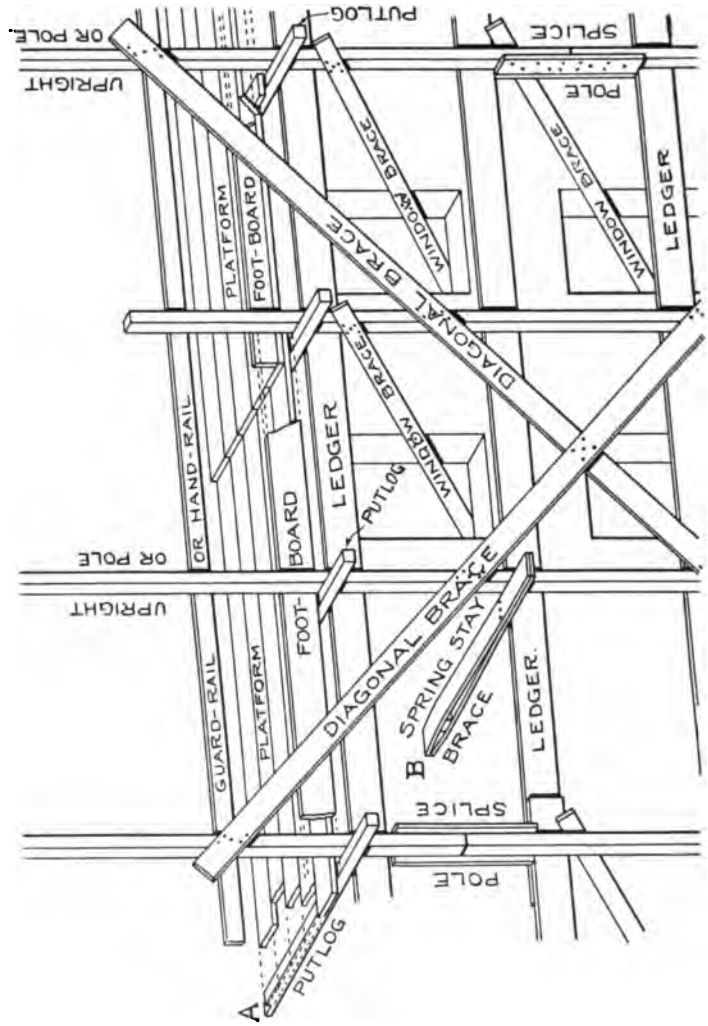

FIG. 8. GENERAL SCHEME OF BRICKLAYERS' POLE SCAFFOLD.
(At *A* and *B*, respectively, the putlog and the spring stay brace enter the wall of the building. For the arrangement of the platform planks at a corner, see page 68.)

lashed together, so as to act like a single piece. When two or more poles are thus secured together to form one upright, they should "break joints";—that is, the splice or joint in any one of the constituent poles should always come opposite the continuous portions of the other poles with which it is associated.

22. Distance of the Poles from the Wall. It is desirable to place the poles as near to the wall as practicable, because the cross-beams (or putlogs) that hold up the platform should not be made longer than necessary, between supports. The standard practice is to set the poles so that there is a clear space of 4 ft. 6 in. between them and the wall. No greater interval than this should be permitted, unless the putlogs are correspondingly strengthened.

23. Spacing of the Poles, Parallel to the Wall. In the usual (or standard) construction, the poles are spaced, parallel to the wall, at a distance of 7 ft. 6 in. from center to center (16 ft. platform planks being then used). When, for any reason, it is impracticable to adopt this uniform interval at all parts of the scaffold, the spacing may be uniformly reduced throughout, or the width of one or more of the pole-intervals (or bays) may be lessened, while the remaining poles remain spaced at the standard distance of 7 ft. 6 in. between centers. In no case, however, should the interval between any two consecutive poles, as measured in a direction parallel to the wall of the building, exceed 7 ft. 6 in. (In England the poles are often set 8 ft. apart, and in Germany they may be as far apart as three meters, or 9 ft. 10 in.; but in English and German practice the scaffold is designed differently from our own in other respects also, and allowance is

made, in proportioning the parts, for the increased stresses that arise from the greater intervals between the poles.)

24. Bearing of the Pole at its Lower End. The uprights of a pole scaffold should never be allowed to simply rest upon the surface of the ground. They should always be securely fixed at their lower ends, so that a displacement, in any direction whatsoever, shall be altogether impossible. Under ordinary conditions

FIG. 9. SCAFFOLD POLE IMPROPERLY SECURED AT THE FOOT.

(The builder who had charge of the job on which this was found is a man of unusual intelligence, yet he considered this support "good enough". Cases far worse than the one here shown are common.)

a hole should be dug in the ground to receive the foot of each pole, the hole being not less than 8 in. or 10 in. deep, and not larger in diameter than is necessary for the purpose in view. The end of the pole should be placed centrally in the hole, and be brought firmly against the undisturbed earth at the bottom, if this be hard and stony; after which the soil that has been removed should be put back again, and be solidly rammed in around the foot of the pole.

When the soil is of such a soft nature, either by reason of its natural character or because of recent heavy rains, that there is reason to fear that the pole might sink into it, even slightly, when the scaffold has been erected and put into service, the hole that is dug to receive the pole should be made larger than usual, and a stout and sound block or piece of plank, about a foot square and not less than two inches thick, should be placed at the bottom of the hole to distribute the load. Care should be taken to see that the block is approximately level, and that all parts of its under surface rest securely against the earth below. The pole should be solidly fastened to the center of the block, either by four or more large, stout nails, or by some other equally effective means. The hole is then to be filled up as before, and the filling well rammed in.

If the scaffold is to remain in place for a long time, the bottom of the pole should be well coated with tar to a height of about six inches above the surface of the ground. This precaution, which is to guard against rotting, is of course unnecessary when the poles are to stand for only a few weeks.

When holes cannot well be dug for receiving the poles (as, for example, when the poles must come direct-

ly over a stone sidewalk or street), some other equally effective means of fixation should be substituted. For example, the poles may be made fast to a stout sill, which is itself secured in some safe and proper manner, by braces or shores or otherwise. Detailed general advice respecting the method to be used can hardly be given, because much depends upon the exact conditions that must be met; but whatever these conditions are, some means should be found and applied, for so fixing the poles at their lower ends that they cannot become displaced, either by sinking into the ground or by sliding sidewise.

It was formerly more or less common to place the lower end of the pole centrally in a barrel or cask, which was then filled with sand or earth, solidly rammed in. This method is now seldom used in the United States, but it is sometimes worth consideration. While it is far inferior to burying the end of the pole in the manner described above, it is equally superior to the common but improper practice of merely letting the end rest upon the surface of the ground, without any form of safeguard or protection.

It should always be remembered that wagons are likely to back up against the uprights, in the course of the work that must go on about the foot of a scaffold, and beams or other materials that are being handled may also swing against them. It is therefore important to make the uprights far more secure than they would need to be for the mere support of the normal weight they have to bear.

25. Landslides or Slips. Care should be taken, not only to see that the poles do not sink into the ground, and that they are neither displaced nor broken,

but also to see that the ground upon which they rest is itself solid and secure. The poles may have to be erected in the vicinity of a cesspool or an old well or some other excavation, or near the upper edge of a bank or terrace; and in such cases it is important to consider the possibility of the sliding or slipping of the ground, under the influence of the extra load thrown upon it by the weight that will rest upon the scaffold poles. Dangers of this kind vary with the nature of the soil, and the same soil is more hazardous when wet than it is when dry. After a heavy rain the ground about the foot of a scaffold should be carefully considered, in all cases of this kind, to determine whether the increase in its moisture may not have made the footings of the poles insecure. Danger from this source may often be overcome by bracing or shoring the uprights to some solid structure near by; but each problem of this kind must be considered by itself, and solved with reference to the special circumstances under which it arises.

26. Splicing or Lengthening the Poles. The poles or uprights that are used in the construction of bricklayers' scaffolds in the United States are usually from 20 to 25 feet in length, and when it is necessary to carry the scaffold to a greater height than this, they must be extended in some way. To increase the height of an upright, a second pole is erected upon the end of the first one; and this part of the work must be carried out carefully and intelligently, so that the joint or splice may be safe in all respects. In Europe it is customary to let the two poles that are to be joined overlap each other by five or six feet, and to bind them together securely by clamps, rope, or metal cord; but in this country the upper pole is set squarely upon the end of the

FIG. 10. A SCAFFOLD POLE, CUT OFF WHILE THE SCAFFOLD WAS IN USE.

(The pole marked "B" was a short, auxiliary one, which was not secured to the rest of the structure solidly enough to receive much of the load. The one marked "A" was the true corner pole of the scaffold, and some person had sawed it off, presumably because it was in his way. This photograph affords a good illustration of the astonishing thoughtlessness or carelessness manifested by persons working about scaffolds.)

lower one, and fastened to it by means of cleats that are securely nailed to both poles. These cleats should be of good, sound material, not less than 1 1/4 in. thick, and they should be somewhat wider than the poles. They

should be not less than four feet long, and be placed so that they overlap each pole by not less than two feet; and they should be secured to the poles by nailing with 10-penny cut nails, not less than six nails being used to fasten each cleat to each pole (The character of the nails is further considered in paragraph 79.)

Two such cleats should be used to every joint or splice, and the cleats should not be nailed to opposite sides of the poles, but to two adjoining sides, so that they may lie at right angles to each other, and so provide proper stiffness and support in every direction. They must moreover be placed so that they will not interfere with either the ledgers or the hand-rails, which are presently to be described. The abutting ends of the two poles should also be perfectly square and flat, so that a good bearing may be had.

It is highly desirable to "break joints" in erecting the uprights of pole scaffolds. That is, it is preferable to avoid splicing two or more consecutive or contiguous uprights at the same general level. This is because a splice or joint, as made by nails and cleats, has but little stiffness in comparison with the pole itself, and hence by splicing alternate uprights at different levels the scaffold as a whole is rendered much stiffer, and is correspondingly less likely to collapse through the buckling of the poles.

THE LEDGERS

27. Function of the Ledgers. The ledgers are the horizontal stringers that run from pole to pole, parallel to the wall of the building. They support the cross-beams or putlogs upon which the platform rests, and transmit the weight of the platform, and of whatever

is upon it, to the poles or uprights. They also serve to stiffen the poles and prevent them from bending, individually, in a direction parallel to the wall (or lengthwise of the scaffold). They do not prevent the poles from all yielding simultaneously, however, and this fact must not be forgotten in considering the bracing of the scaffold, which is discussed in a subsequent section.

28. Material, Size, and Quality. The ledgers, like the poles, are preferably made of spruce. Hemlock should never be used, for the reasons already given in paragraph 20, in discussing the poles. Ledgers should not be less than 1 1/4 in. thick, and it is advisable to make them 12 in. wide for heavy work, although a width of 10 in, is sufficient when the load on the platform is sure to be light, and the putlogs are kept close to the poles, as explained in paragraph 39. Ledgers as narrow as 8 in. are often used, and it must be admitted that they seldom break when they are made of first-class stock and not loaded heavily; but we greatly prefer a minimum width of 10 in.

The length of the ledgers will depend upon the spacing of the poles to which they are secured. When the poles are set at the standard interval of 7 ft. 6 in. between centers, the ledgers should be at least 16 ft. long. This allows them to extend across two bays (or two consecutive pole-spaces), and to lap over the poles by a few inches at each end, so that they can be properly nailed.

The ledgers should be made of material that is sound and first class in every respect. They should be free from bad knots or cross-grained places or shakes, and they should be straight and flat and thoroughly

seasoned. A winding (or twisted) ledger cannot be secured to the poles satisfactorily, and an unseasoned one is likely to warp and twist out of shape while in use, so as to either start the nails by which it is held, or throw a severe and entirely unnecessary stress upon them.

Ledgers are likely to become badly split at the ends after they have been used a few times. (See paragraph 33.) Great attention should be paid to their condition in this respect, and any that are split to a serious extent should be discarded and used thereafter for other purposes. Ledgers should also be rejected when they have become weakened to any material extent by nail holes, even if they are not split.

29. Relation of the Ledgers to the Poles. Some scaffold builders nail the ledgers to the inner sides of the poles, while others nail them to the outer sides, and some prefer to put them alternately inside and outside. So far as safety is concerned, there is some advantage in nailing them to the inner sides because the span of the putlogs is somewhat less in that case,—the gain in this respect being 5 1/4 in. when the pole is 4 in. square and the ledger is 1 1/4 in. thick. Where the scaffold turns a right angle the ledgers coming together at the corner pole cannot be secured to it properly if both are on the inside; hence builders who prefer to run the ledgers inside often spring one of them so that it runs outside of the corner pole and inside of the others. When two ledgers meet at right angles one of them is nailed with its end flush with the pole, and the other is allowed to lap over in the usual manner. The one that stops flush with the pole should be sawed off truly square, so that it may have as full a bearing as possible, and offer a sufficient area for good nailing.

30. Vertical Spacing of Ledgers. The distance from any given ledger to the one next above it is determined by the manner in which the scaffold is used. With the platform at a given level, the men lay the wall until it has reached a height beyond which further work would be inconvenient. The platform is then raised so as to rest upon another series of ledgers at a somewhat higher level, and the job progresses in this way until the wall is completed,—all the work of bricklaying being done from a single platform, which is shifted upward from time to time, so as to be always within a convenient distance of the level at which the bricks are being set. The height from the upper edge of one ledger to the upper edge of the one next above it, as thus determined, is approximately 5 ft. 2 in. As the platform is raised with the progress of the work, the ledgers upon which it has rested at previous stages are not removed, but are left in position to brace and stiffen the poles against displacement in a direction parallel to the length of the platform.

31. Erecting the Ledgers. While the bricklayers are at work at one level, the ledgers that are required for the support of the platform in its next higher position are fixed in place. In putting up a new ledger, a furring strip or cleat is first nailed to each pole to support the weight of the ledger until it can be properly nailed on, and to afford it a certain measure of permanent support in addition to that given by its own nails. There is no standard size for these cleats or strips, but they should be an inch or more in thickness, and at least two inches in width, and 10 in. or 12 in. long; and each should be secured to its pole by several nails. The ledger is next laid in position against the poles

with its weight resting upon the furring strips, and is nailed in place. Care should be taken to see that the ledgers are level, and that their top edges are at the same height as the bottom of the openings left in the wall, opposite them, for receiving the ends of the put-logs. Care should also be taken to see that each ledger overlaps the poles by the same amount at each end, so that the final nailing may be done equally well in all places.

32. Nailing. Each ledger should be nailed to each pole with five first-class 10-penny cut nails. The 8-penny size is not large enough for safety. (The quality of the nails is considered in paragraph 79.) Where two ledgers lap over each other on the same pole, the under one should be first nailed to the pole as here described, and the outer ledger should then be nailed to the under one just as though it were being secured directly to a pole. The nails should be well distributed in all cases, and none of them should be driven close to the top edge of a ledger.

It is easy for the man who is erecting a bricklayers' scaffold to make serious mistakes and oversights, even though he may know quite well what the construction ought to be, and have every intention of carrying it out properly. In putting up a ledger, for example, it is common practice to tack one end with a single nail, just to hold it in place for the time being, and then to begin the work of permanent nailing from the other end. In proceeding in this way the workman may forget that he has not secured the first end properly, thus leaving it with but a single nail, which may perhaps not even be fully driven home. An oversight of this kind is very likely indeed to result in a fall,

when the weight of the loaded platform comes upon the defectively fastened ledger. It is much better to complete the nailing at the first end before proceeding to the other end, or to the middle. A final tentative shake, given by the hand to each end of the ledger and to its middle point, will betray any omission that may have been made in the nailing, but it would probably fail to give proper warning if some part were slightly tacked, but not secured properly.

The man charged with the erection of a scaffold should never have any other job in hand at the same time, and while he is engaged in the work of erection his attention should never be drawn away from it for any reason whatsoever, except for the avoidance of some other more imminent danger.

One man can do most of the work of erecting a bricklayers' scaffold that is constructed in accordance with American practice. He will need assistance mainly in raising the poles or uprights, and in carrying the planks and other needful materials to the working platforms.

33. Splitting of Ledgers. When the ledgers are nailed to the poles, as herein described, the holding power of the nails is such that in dismantling the scaffold the ledgers are apt to become badly split at the ends. This trouble is so common and so marked that the ledgers are often damaged, by once using them, to such an extent that they should be immediately discarded. As a result, builders of scaffolds are tempted to use ledgers that are not in proper condition, because of the expense involved in procuring new material for each new job.

The splitting of the ledgers at the ends is caused

mainly by unnecessarily rough treatment, the men striking them heavily on the back with their hammers, to draw the nails. The splitting can be reduced in large measure by striking, not directly upon the ledger itself, but upon a block held against it. It cannot be wholly prevented in this way, however.

Ledgers can best be removed from the poles by using a stirrup-shaped special tool that can be turned out easily and quickly by any blacksmith. To make this tool, select a bar of iron about 3/4 inch square and four feet or so in length, and at one end turn about a foot of it back parallel to the main length of the bar so that it lies at a distance from it equal to, or slightly exceeding, the thickness of the ledger. In using the

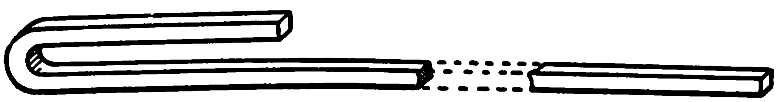

FIG. 11. A SPECIAL TOOL FOR REMOVING LEDGERS FROM POLES.

tool, catch the ledger to its full width, and as near to the pole as possible, in the V-shaped space between the shank of the bar and the turned-over end, and work it loose by moving the tool backward and forward. Ledgers may be taken off, in this way, with little or no splitting, and their usefulness will be correspondingly prolonged.

34. Clamps. To lessen the damage to the ledgers from nails, they are sometimes secured to the poles by means of clamps. Various forms of clamps have been designed for this purpose, but none of them have come into general use in the United States. They have been applied here to some extent in the past few

years, however, and they are quite widely used in Germany. Some of them, in sparing the ledgers, damage the poles to a corresponding extent. One form of clamp which has been used quite a little in this country is shown in Fig. 12, from which its construction and mode of application can be clearly seen.

FIG. 12. A FORM OF LEDGER CLAMP IN USE BY AMERICAN BUILDERS.

THE PUTLOGS

35. Function of the Putlogs. The putlogs (also known among masons and builders as "putlocks", "puds", or "cross-bars"), are the horizontal pieces that run perpendicularly to the wall and afford direct and immediate support to the planking of the platform. They occur, in one form or another, in nearly all types of scaffolds. In the American type of the bricklayers' pole scaffold, here under consideration, they are merely short wooden beams, square or rectangular in cross-section, and supported at one end by the wall that is being laid, and at the other by the ledgers of the scaffold.

36. Material, Size, and Quality. Of the various kinds of wood that are available for making putlogs, chestnut is considered to be the best, in this country. In England birch is quite commonly used, but American practice does not favor it. Spruce is often used for putlogs, and it answers very well when chestnut cannot be had conveniently. The rapid spread of the apparently incurable "chestnut blight" threatens the extermination of the chestnut tree, and hence it is probable that spruce will be more and more employed for putlogs as the years go by.

In the selection of material for the putlogs, great care should be taken to avoid pieces that are defective or inferior in any way. The wood should be sound and free from knots, and of first-class quality in every respect. Special attention should be paid to its grain, which should be straight and close. In English practice the putlogs, when rectangular in section, are usually split instead of being sawed, in order

to avoid cutting any of the fibers upon the continuity of which the strength of the putlog depends, and also, no doubt, because only good logs can be split properly. In Germany, too, split or hewn material is preferred, though its use is not mandatory. There is no need of insisting that the putlogs be split, but the attention that has been given to this matter in other countries will serve to emphasize the importance of seeing to it that the material is sound, and perfectly straight-grained.

Putlogs should be at least 4 inches square, in the bricklayers' scaffold as built in the United States, when the load that is to be carried by the platform is of the usual nature and amount; and they should be correspondingly larger if the load to be carried is heavier than usual. It is common to find putlogs having a section 3 inches by 4 inches, and while this is sufficient in many cases, the larger size is greatly to be preferred, even for light loads.

The putlogs should be long enough to project over the ledgers by not less than one foot. If there is a clear space of 4 feet 6 inches between the poles and the wall of the building, this means that the putlog should be a little over 6 feet in length.

37. Support of the Putlogs. In the bricklayers' scaffold, the end of the putlog that is nearest the building is usually supported directly by the wall that is being built. For this purpose a brick is left out of the wall at the proper place, and one end of the putlog is inserted in the opening so made. To make it possible to do this, the putlog is notched or cut down, at the end, so as to be narrow enough in the vertical direction to be capable of entering the hole left in the wall by

the omission of the brick. The notch should be cut from the *upper* side of the putlog, so that the projection that enters the hole in the wall is on the lower side. This is important, because there would be considerable likelihood of the putlog splitting, if its bottom fibers were cut in making the notch and the projection supporting the weight were at the top. The notch should be just deep enough to permit the end of the putlog to enter the hole in the wall, and should not extend into the putlog for more than 4 1/2 or 5 inches, as measured in the direction of its length. Care should be taken to see that the putlog enters the wall to the full width

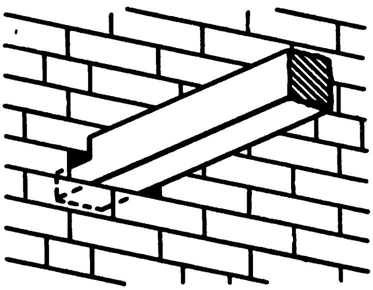

FIG. 13. CORRECT POSITION OF PUTLOG.

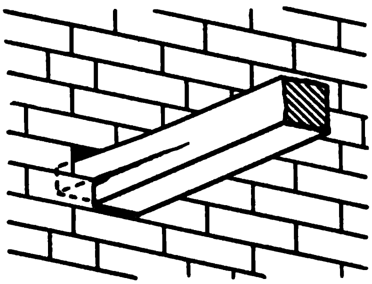

FIG. 14. INCORRECT POSITION OF PUTLOG.

of one brick (or say 4 inches), but it should not be allowed to enter to a greater distance than this.

When the wall that is to be built has many window openings, it often happens that one of them comes at a point where a putlog would naturally be placed. In this case it is common to arrange some form of support within the window space, to hold up the end of the putlog. A piece of stout plank, set vertically, and resting solidly upon the bottom of the window opening or upon some other secure foundation, may be

used; but every care should be taken to brace this plank so securely that it will be comparable in solidity to the wall itself. It should be made secure against every possible kind of displacement,—against tipping, either in or out or sidewise, and against the displacement of its lower end in any manner.

38. Security of Putlogs. In Great Britain and in continental Europe it is customary to lash the putlogs to the ledgers with metal cord or small rope, or to fasten them with clamps; but in the United States the putlogs are usually permitted to rest upon the ledgers without being secured in any way, it being here considered that the weight upon the platform is sufficient to prevent the putlogs from becoming displaced, either at the ledgers or at the wall. It might appear that this practice could not be approved by the conservative safety engineer, but experience has shown that there are few accidents that are traceable to the displacement of the putlogs, except as this may have occurred in consequence of inadequate or improper bracing, or of other errors of construction or practice for which the putlogs are in no way responsible. The putlogs, where they enter the wall, are sometimes secured by wedges, but this is not at all common. (See paragraph 153.)

Putlogs having a cross-section differing from the square form to any marked extent should not be used unless they are secured in some safe way, or have broad flat sides where they rest upon the ledgers. The putlogs of Europe which are lashed to the ledgers are often round in section, and the lashing is therefore highly important; but those that we use have a square or rectangular section and are therefore far more stable. If unsecured putlogs of rectangular cross-section are

employed, with a height considerably greater than their width (as would be the case when using planks turned up edgewise), there is danger of the platform being unstable or unsteady, from the tendency of the putlogs to cant over upon their sides. It may not be possible for them to turn completely over, on account of the restraining influence of the wall upon their ends; but they may nevertheless be capable of turning to some considerable extent, and a sudden disturbance of the platform from this cause might easily throw the workmen off their feet and lead to a serious accident.

39. Location of Putlogs. There should be at least three putlogs under every plank of the platform,—one at each of the respective ends of the plank and one in the middle. By adhering to the general proportions and dimensions that are recommended in this book for the parts of the scaffold, it is easy to conform to this condition.

As it is through the putlogs that the load upon the platform of the scaffold is transmitted to the ledgers, it is important to place them so that they rest upon the ledgers as closely to the poles as possible, in order to keep the bending stresses upon the ledgers small. It may sometimes be necessary, in spacing the putlogs properly, to place one or more of them at a little distance from the nearest pole; but the importance of transmitting the load to the poles very directly and immediately should be borne in mind continually, and no departure from this principle should be permitted without good and sufficient reason.

Care should be taken to have the putlogs truly level,—this being insured by the proper placing of the ledgers, rather than by adjusting the putlogs them-

selves. With the usual form of putlog the top of the ledger should come directly opposite the bottom of the hole in the wall into which the putlog is to enter.

The putlogs should also be placed as nearly square to the wall as possible, because this gives the best distribution of the stresses that are produced in the scaffold by the load on the platform, and also affords the best support to the platform planks themselves.

40. Treatment of Corners. Where the scaffold turns a corner, one or two putlogs should be laid diagonally across the corner, so that each may have one of its ends resting upon each of the two ledgers that meet at the corner. In placing a putlog in this way it is better not to run it at an angle of 45 degrees with the ledgers, because unless the putlog is unusually long that would leave both of its ends at a considerable distance from any pole. It is better to have one end of it near the corner pole, letting the other end come at such distance from the pole as may be necessary in order to accommodate the planking. This point is more fully explained in paragraph 45, in discussing the platform of the scaffold.

41. Special Forms of Putlogs. At the present time walls are often laid with wide intervals between the rows of brick, a space of 5/8 inch being more or less common. This has led to the devising of forms of putlogs that enable the builder to erect a bricklayers' scaffold without leaving out bricks here and there for the support of the platform. In one of these special designs the putlog is of the usual shape and dimensions, but instead of being notched at the end it is fitted there with a sort of shoe consisting of two pieces of sheet steel, each about 1/4 inch in thickness. One of these

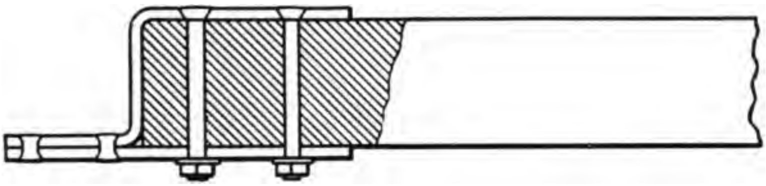

FIG. 15. A SPECIAL PUTLOG FOR USE ON WALLS WITH WIDELY-SPACED BRICKS.

pieces is straight and lies along the bottom of the putlog, while the other is bent at right angles twice, so that it lies along the top of the putlog for a distance of 8 inches or so, then passes down over the end of it, and finally turns again in the direction of the length of the putlog and follows snugly along the bottom part of the shoe, projecting out beyond the end of the putlog to a distance of not more than 4 1/2 or 5 inches. The two strips of steel are bolted together solidly by bolts passing vertically through the putlog,

FIG. 16. A SPECIAL PUTLOG FOR USE ON ORDINARY WALLS.

(The lower edge of the projecting steel tongue should be exactly parallel with the length of the putlog. Note that in the illustration the tongue has been forced upward, by use, until it would bear against the brickwork only at a single point, close to the putlog.)

and their free ends should also be united by countersunk rivets. In using this form of putlog the projecting steel tongue is laid upon the wall in the usual way, but it is not necessary to omit a brick for its accommodation, because, with the wide spacing of the bricks, there is room for the tongue between two successive rows.

Another form of putlog, which is also designed to do away with the temporary omission of bricks from the wall, is shown in Fig. 16. The essential feature of this is the sheet steel tongue which projects at the end, and which, when the putlog is in position, rests edgewise upon the wall in the vertical space between the ends of two successive bricks. The tongue is held in place by two bolts which pass through a steel strap that incloses the end of the wooden part of the putlog. This strap is a highly important element in the design, because if it were not present the stresses that come upon the bolts that hold the tongue would be likely to split the putlog and let the platform down.

THE PLATFORM

42. Material, Size, and Quality of Platform Planks. The platform consists of planks laid directly upon the putlogs, and running parallel with the wall of the building. The planks are usually made of spruce, and, like all other parts of the scaffold, they should be of carefully selected material, straight-grained, sound, and free from bad knots or other imperfections. They should never be made of hemlock, because, as already explained, this wood is likely to break short off without warning when heavily loaded, and it sometimes fails when there appears to be no adequate reason for failure. The size of platform planks varies

somewhat in different parts of the country. In New York they are supposed to be 16 feet long, 9 inches wide, and 2 inches thick. This size is not prescribed by any law or ordinance, but it is established as a sort of trade standard, among builders. The spacing of the poles and the putlogs, as herein recommended, is based upon the use of planks 16 feet in length, and if shorter ones are used the poles and putlogs must be set correspondingly nearer together. Planks less than 2 inches thick are not recommended for platforms that are to be used for laying brick. In England the platform planks are frequently bound with hoop-iron at the ends, to prevent splitting. This is seldom done in the United States, and it is doubtful if it is really the best possible practice, because the hoop-iron is likely to become loosened or broken with service, and injuries to the workmen from tripping, or from the cutting of their hands or feet by the loose ends or edges, are likely to result.

43. Width of Platform. When 9-inch planks are used, five of them are commonly laid side by side to form the floor of the platform. When this arrangement is adopted, and the poles are set so as to leave a clear space of 4 ft. 6 in. between their inner surfaces and the face of the wall, nine inches of the length of each putlog, inside of the poles, will not be covered by planking. The planks should be so placed that some part of this nine inches comes between the wall and the inner edge of the platform. The space so left should be wide enough to enable the workman to reach parts of the wall that are a few inches below the floor of the platform, but it should never be wide enough to become a source of danger from the fall of materials or tools, nor (in extreme cases) of persons.

The planks of the platform should be laid with their edges close together, so that the platform will be "tight", and have no spaces through which small tools or fragments of materials can fall.

In parts of the country in which the standard platform plank is other than nine inches wide, the number of planks that must be laid side by side to form the platform will naturally be greater or less than five. The actual width of the floor of the platform should be about four feet in any case, and it should never be enough greater than this to require the poles or uprights of the scaffold to be set further from the wall than the standard 4 feet 6 inches.

44. Support of the Planking by the Putlogs. The platform planks are not nailed to the putlogs, nor secured to them in any manner. It is necessary to raise the platform at intervals, as described in paragraph 46; and the repeated driving and withdrawing of nails would consume a great deal of time, and would also damage both the planks and the putlogs, so that they would soon become weakened and unfit for use. The platform might be lashed in place with rope or wire, or it might be secured by appropriate clamps; but experience has shown that there should be no need of fastening the planks in any way, if the scaffold is built in faithful accordance with the principles laid down in this manual. The weight of the planks, together with that of the load upon them, is sufficient, under these conditions, to prevent displacement when the scaffold is properly used.

Special care should be taken to lay the planks so that they cannot tip up, either from workmen stepping upon unsupported ends, or from materials being de-

posited upon the platform at any point. In conformity with this principle, the planking should nowhere be allowed to project more than one foot beyond the last putlog, at any free end of the scaffold platform.

Where two successive lengths of planking meet, they should never be allowed to abut upon a putlog, end to end, because a slight shift of either plank would then be likely to lead to an accident. Platform planks are often laid end to end in England, but they are not allowed to abut upon the same putlog. Two parallel putlogs, set about four inches apart, are provided in such cases, one supporting one of the planks and the other supporting the other one.

The arrangement of the planking where the platform of a bricklayer's scaffold turns a corner is considered in paragraph 45. At all other parts of the platform there should be at least three putlogs under every plank,—one near each end of the plank, and one at or near its middle point. This condition can be fulfilled very easily, when 16-foot planks are used and the poles of the scaffold are set 7 1/2 feet apart. Each plank will then be twelve inches longer than the distance from the middle of any one pole to the middle of the second pole beyond; and if a putlog is set at every pole, each plank can therefore be laid so that it will have a putlog under its middle point, and will also project, at both ends, six inches beyond the center lines of other putlogs. The planks should never overlap the center lines of the putlogs by less than six inches, and care should be taken to space the putlogs uniformly and correctly, and to see that each plank overlaps by equal amounts at both its ends.

When one section of planking has been laid upon the putlogs in this manner, the next section is allowed to rest upon the first one, and so the platform is continued,—the first, third, and fifth sections resting directly upon the putlogs, and serving, at the same time, to support the second and fourth sections. The general scheme of this arrangement will be understood by reference to Fig. 17, in which the planks composing

Fig. 17. Usual Arrangement of the Platform Planks.

the platform are seen to lie on two different levels,—every other length resting upon the putlogs, while the intervening lengths stand higher by the thickness of a plank. Some builders prefer the plan suggested in Fig. 18, however, where each length of planking rests directly upon a putlog at one end, and upon the previously-laid planking at the other end. In either case, each course of planking will overlap the next one by

Fig. 18. Another Method of Laying the Planks.

twelve inches, since each overlaps the center line of the putlog by six inches.

Every plank should rest firmly upon the putlogs, or upon other planks, at all points where it is designed to be supported. If this condition is not fulfilled, the load upon the platform will not be properly distributed to the poles; and the planks will also spring and yield, so that the fcoting will be uncertain, and accidents may result. The support of the planking should receive

special attention at the middle of the courses that are elevated by resting upon other planks. At every such point (see *A*, in Fig. 19), a putlog of extra depth should be used, or else a strip should be tacked to the top of an ordinary putlog, of just the right thickness to compensate for the slight elevation of the plank at this point.

45. Treatment of Corners. Where a bricklayer's pole scaffold turns a corner, special attention should be paid to the arrangement of planks that form the flooring. As already explained in paragraph 40, the putlog that is to support the planking at the corner should not be set at an angle of 45 degrees, but should be placed so that it will rest upon one of the ledgers at a point near the corner pole, and upon the other

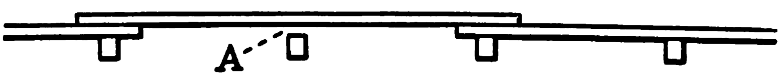

FIG. 19. SHOWING THE NEED OF SPECIAL TREATMENT AT CERTAIN POINTS.

ledger (that runs at right angles to the first one) at a point near to the first pole from the corner,—the poles near the corner of the scaffold being set closer together than elsewhere, so that the putlog that is set in the diagonal position need not be materially longer than the ones that are used to support the straight parts of the platform. The diagonally-placed putlog, when located as here described, will make a sharp (or acute) angle with one of the ledgers, and a blunt (or obtuse) angle with the other one. In laying the flooring of the platform, the planks that meet the putlog most nearly at a right angle should be laid first, and these should extend over the diagonally-placed putlog far enough to have a good, firm, safe bearing, but not far enough to

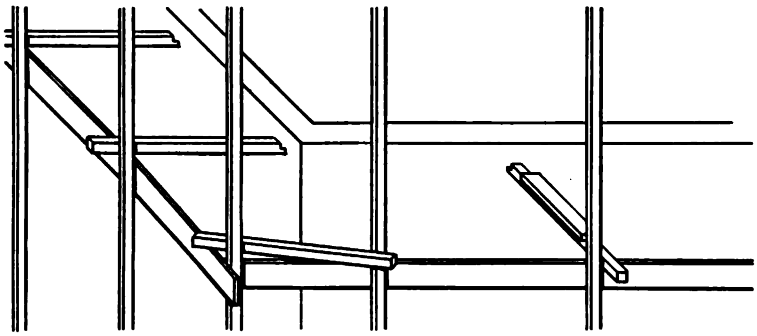

FIG. 20. SHOWING THE CORNER PUTLOG IN POSITION.

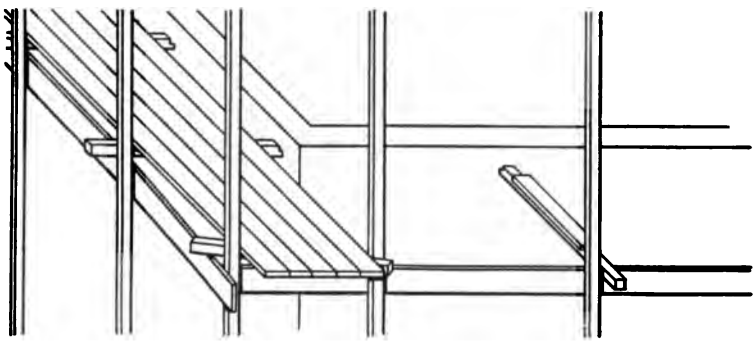

FIG. 21. SHOWING THE FIRST COURSE OF PLANKS IN POSITION.

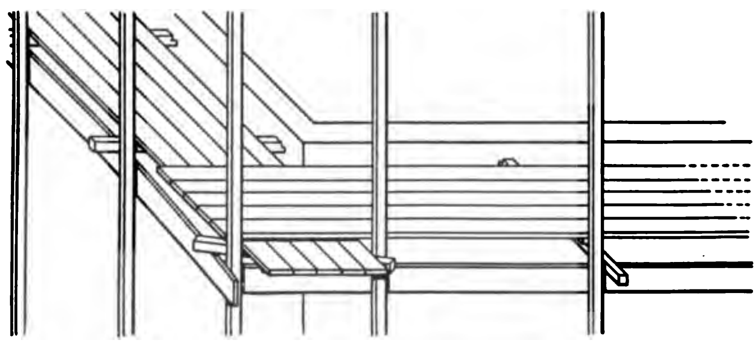

FIG. 22. SHOWING BOTH COURSES OF PLANKING IN POSITION.

involve any danger from tipping, if a workman should step upon the projecting ends.

The first layer of planks having been laid in this manner, so that one of the platforms has been carried up to, and across, the corner of the scaffold, the other platform, running at right angles to the first one, should next be laid, and its planks should extend over and entirely across the first layer. Any load that may be thrown upon the second (or upper) platform near its end is then transferred to the lower one, and from this to the putlog that has been set diagonally at the corner.

The arrangement here recommended for the putlog and planking is clearly shown in Figs. 20 to 22.

46. Shifting the Platform. Whenever the wall that is being laid has risen to a certain height above the platform—about five feet, under ordinary circumstances,—the bricklayers communicate with the men who are charged with the erection of the scaffold, and give notice that they are ready to have the platform raised. New ledger boards have been nailed to the poles, at the proper height, before this time, and when the word to raise the platform has been given, the first step is to set the putlogs that are to support the platform in its new position. The platform that is to be shifted should be left undisturbed until the new putlogs have been put in place, and a sufficient number of extra putlogs should be provided, to make it possible to do this. It is not good practice to take putlogs from under the middle of the planks of the old platform, to use in erecting the new course at the higher level; but in placing the new putlogs, it is convenient to temporarily omit, from the new platform, the ones that will eventually be required under the middle points of the planks,

—the putlogs that are to support the ends of the planks being laid first, and the middle ones being left out until the new platform is otherwise complete, or nearly so. By this means the shifting of the platform planks to the upper level is considerably facilitated, and there is no sacrifice of safety, provided the middle putlogs are not forgotten and omitted permanently. This is not likely to occur, because the spring of the newly-laid planking would betray the absence of these putlogs.

The putlogs for supporting the ends of the planks of the new platform being in position, the planks themselves are next passed up and laid in place. In doing this it is best to leave at least one undisturbed line of planking along the entire length of the old platform until the rest of the platform planks have been shifted to their new positions; and it is advisable to have extra planks at hand, so that the new platform may be laid complete, even to the placing of the putlogs under the middle points of its planks, before the last line of planking is removed from the old platform. Attention to this point will materially reduce the dangers to which the men erecting the scaffold are exposed.

When the platform has been shifted to its new level as here described, any planks that still remain at the old level are removed, and the old putlogs are taken away. Attention is then given to such additional bracing as the increase in the height of the structure may call for, and also to the hand-rails and footboards, as described in subsequent sections, below.

BRACING

47. General Considerations. Pole scaffolds require bracing not only to insure a sufficient de-

gree of stiffness in the scaffold itself, but also to prevent the scaffold from falling away from the building, as a whole.

The splices in the uprights have but little strength for resisting bending stresses, when the successive poles are placed one over another with their ends abutting. This fact should be carefully recognized, and the structure should be braced and supported in such a way that the only stress thrown upon a pole at a splice is the direct vertical thrust that is due to the weight of the scaffold and its load. Moreover, in a high scaffold the poles should be stiffened by braces, even if they are continuous and free from splices; for without braces they would be in the condition of long, thin columns subject to an endwise thrust, and they would therefore be structurally weak, and if the load were at all heavy they would be in danger of failing by springing at their middle points. (See Fig. 23.) This danger is increased by the presence of the splices, and by the fact that the poles are seldom exactly straight, even when special efforts have been made to have them so.

It should also be remembered that it is possible for the scaffold to fall down bodily,—not by the failure of its poles, but by swinging away from the building as a whole, and turning about the lower ends of the supporting poles as a door turns upon its hinges. (See Fig. 24.) It may also collapse by moving parallel to the wall of the building,—the scaffold folding up as it falls, and the poles going down like a row of dominoes. (See Fig. 25.) To guard against failure by either of these methods it is important to have the scaffold properly stiffened and braced, not only by tying its parts together, but also by securing the whole structure

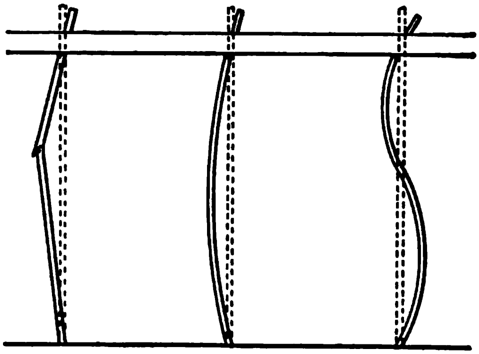

FIG. 23. FAILURE BY THE BUCKLING OF THE POLES.

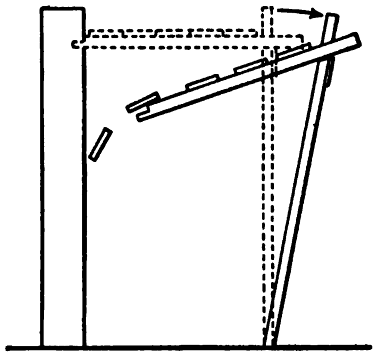

FIG. 24. FAILURE BY FALLING AWAY FROM THE BUILDING.

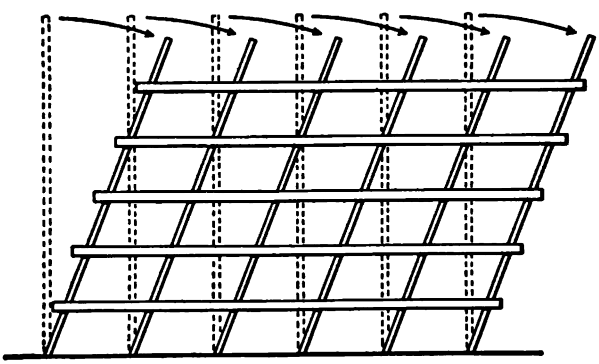

FIG. 25. FAILURE BY COLLAPSING PARALLEL TO THE WALL.

to the building that is being constructed, or to some other fixed and solid object.

In determining the number of braces that are to be used in stiffening a scaffold, careful attention should be paid to the character of the scaffold and to the service that is expected of it. A scaffold that is to extend to a considerable height, and which is likely to be loaded at times with a considerable amount of material, should be braced much more thoroughly and substantially than may be necessary in one that is to extend only to a moderate height and that will be loaded only lightly. Care should be taken, however, to err on the safe side, and to increase and strengthen the bracing in every case in which there is the least doubt of its adequacy.

Braces that are put up for the purpose of holding the scaffold at a proper distance from the wall should always be secured to the ledgers very near to the poles, or to the poles themselves. If they are attached to the ledgers midway between the poles, the support that is afforded is much less secure, because the flexibility of the ledgers will allow the scaffold to move to a considerable extent before the full supporting effect of the braces can be realized.

Braces of inferior material and of too small a size are often used to stiffen or support scaffolds. This is a serious mistake. The material should be of first-class quality in every respect, and the braces should be large enough to safely carry any stress that they could be called upon to bear, even under the most unusual circumstances. The ends of the braces should also be secured in a thoroughly workmanlike manner, and with a sufficient number of nails of the quality indicated in paragraph 79. It should always be remembered,

too, that the stress may be either a tension or a thrust, and the braces should be designed and proportioned accordingly.

48. Bracing at Window Openings. To stiffen the scaffold, and to prevent it from falling over as a whole, it should be attached to the building at many points, and in a most effective manner. At the level of the working platform the putlogs are supposed to tie the scaffold to the wall with sufficient security, and there is seldom any trouble on this score if the putlogs are correct in form, and properly put in place, and carrying their normal load. Putlogs have no value as braces, however, unless they are loaded; for they are seldom fastened in any way, either to the ledgers or to the building, and their effectiveness in holding the scaffold to the wall depends solely upon their friction against the ledgers and the brickwork.

When the wall beside the scaffold contains a considerable number of window openings, braces may be run to these openings from the poles of the scaffold. At their outer ends, these braces are to be securely fastened to the poles. At their inner ends they may be attached to the window frames, but if the floors are carried up sufficiently to make such a course possible, it is much better to run the braces *through* the windows, fastening them to the joists of the floors inside, or to the flooring itself. In such cases it is well to nail them to the window frames also, because greater stiffness is secured in this way; but it is not the best practice to attach them to the window frames alone, if use can be made of the flooring also. When reliance is placed mainly upon window braces, every window opening should receive at least one or two or them; for although

the support that is thus provided will sometimes be insufficient, there are few cases in which it will be at all excessive. In fact, additional bracing of some other form should be used, in any event, unless the windows are numerous and close together, and are spaced at fairly uniform distances.

If the window braces are set obliquely to the wall, with half of them running in one direction and half in the other, they will serve not only to hold the scaffold at the right distance from the wall, but also to stiffen it considerably in a lengthwise direction, so as to prevent it from collapsing by turning about the ends of its own poles, in a direction parallel to the wall. (See Fig. 25.)

49. Shoring. When the window openings are few in number, or when the floors are not laid rapidly enough to remain at all times within a short distance of the scaffold platform, it is often necessary to employ some form of bracing other than the window bracing described in the preceding paragraph. If the outer edge of the scaffold stands near to another building that has been previously erected, shores for the support of the scaffold can often be run between the new wall and the old one. In the absence of any such convenient building, shores can also be run from the scaffold to the ground, in some cases, although this method of bracing is seldom practicable except for the lower levels of the scaffold. Moreover, shores running to the ground are usually in the way of the workmen, and they are also likely to be disturbed by teams, or by beams or other materials that are being hoisted or shifted about.

When shores are used, and whether they rest against another building or against the ground, the

scaffold poles that they support should be kept away from the wall by the use of struts of the proper size and length, so that the poles cannot be forced toward the wall by the weight of the shores, or from any other cause. For scaffold work, shoring is decidedly inferior to other methods of bracing, and it should be adopted only when the other available methods are open to serious special objections. As a rule, spring stays are greatly preferable, if they are put up in a workmanlike manner.

50. Spring Stay Braces. The spring stay, which is widely used for bracing scaffolds to their walls, consists of a pair of boards not wider than the length of a brick, and set so as to run from one of the putlog holes that are left in the wall as the scaffold goes up, to the pole or ledger opposite this putlog hole. It is put in position *after removing the putlog*, in raising the platform to a higher level. The ends of both boards are thrust into the putlog hole as far as they will go (which should not be less than the width of a brick). A brick is then laid between the two, after which their outer ends are brought forcibly together, and nailed to the ledger. This causes the inner ends of the boards to press against the upper and lower surfaces of the putlog hole so powerfully that the brace cannot be pulled out without the exertion of a very considerable force. The boards that are used should be sound and perfect in all respects, and the brace should be nailed to the ledger close to one of the poles, in order to obtain as stiff a construction as possible. It is never hard to do this if the scaffold has been correctly designed and constructed, because the putlog holes will then be opposite the poles, in all cases.

Spring braces are effective, and they rarely fail when correctly put in. The brick that holds the component boards of the brace apart should be set as near to the wall as is consistent with bringing the outer ends of the brace together, because the grip of the brace upon the putlog hole is greater, the nearer the wall the fulcrum brick is set. Care must be taken, however, to keep this brick far enough from the wall to prevent overstraining the boards composing the brace, because

Fig. 26. An Excellent Example of Spring Staying.

if either of them should fracture, the efficacy of the brace would be destroyed at once. In nailing the outer ends of a spring stay to the ledger, care should be taken to use a sufficient number of nails of first-class quality, and to have them large enough to insure the holding of the brace to the ledger.

When reliance is placed wholly upon spring braces for maintaining a scaffold at a proper distance from the wall, it should be remembered that braces of this kind give little or no lengthwise stiffness to the scaffold, and separate provision should therefore be made for insuring stability in that direction.

In applying spring braces, it is best and safest to set one of them in every putlog hole, as illustrated in Fig. 26. Many builders consider it sufficient, however, to set them in the holes that stand opposite the even ledgers,—that is, in the holes that are opposite the second ledger of the scaffold, and opposite the fourth, sixth, and so on, counting upward from the ground. The omission of the braces from every other row of holes, in this way, may or may not be justifiable, according to the nature of the scaffold in other respects. If it is low and lightly loaded, and has stout and sound poles, the omission of the spring braces at every alternate ledger may be defensible; but it is preferable, under all circumstances, to stay the scaffold at every putlog hole, as recommended above. Whichever plan is adopted, a stay should be provided for every putlog hole in the horizontal rows in which these stays are used, because it is important that every pole should be supported; and the stays should never be omitted, under any circumstances, from *more* than every alternate horizontal row of putlog holes. It is particularly im-

portant to stiffen the scaffold, by spring stays or otherwise, at or near the points where its poles are spliced; because the poles are always weaker at those points than they are elsewhere.

When spring stays are used for bracing a scaffold, it often happens that some of the places where stays are needed come opposite window openings in the wall. In cases of this kind the required support should be provided by the use of ordinary straight braces, passing through the windows to the flooring as described in paragraph 48, or by similar braces securely fastened to the window frames, in case the flooring has not been laid to a height sufficient to afford suitable anchorage.

51. Caution in the Use of Special Putlogs. When the platform of the scaffold is supported by putlogs of special form (such as those described in paragraph 41), which are designed for avoiding the necessity of leaving openings in the wall by the omission of bricks, the bracing is often glaringly inadequate. Spring stays cannot be used in such cases, and there may be but few window openings. It is all too common, under these circumstances, to merely leave some of the special putlogs in position as the scaffold goes up, and to rely upon them, wholly, for obtaining the desired rigidity. This is decidedly inadvisable, because the holding power of these putlogs, at the wall, depends altogether upon the way in which the workmen lay the bricks and mortar around them; and as the bricklayer often gives no special thought to the holding power that the putlog is to have in its subsequent capacity as a brace, he is likely to leave its inner end as free as possible, to facilitate the removal of the putlog when the platform is raised, or when the scaffold itself

is taken down. Furthermore, the holding power of these special putlogs is zero after the weight of the platform has been removed from them, unless they are nailed to the ledgers; and as nailing damages the putlog, it is apt to be done inadequately. As a matter of fact, the nailing is often neglected altogether, and where these special putlogs are used it is not uncommon to find that only a few of them are nailed either to the ledgers or to the poles. A scaffold of this kind sometimes appears to be properly braced, at first glance, although it may become evident, upon shaking one or two of the poles, that most of the putlogs are entirely free from the poles and the ledgers, and are totally useless as braces. It is clear, therefore, that when putlogs of special form are used, the foreman, or some other person skilled in scaffold construction, should be specially designated as a supervisor or inspector of the bracing, and should be held personally responsible for the safety of the scaffold in this respect.

52. Longitudinal Bracing. Adequate provision of some sort should be made to prevent the scaffold from falling in a direction parallel to the building, as suggested in Fig. 25. Too little attention is given to this point in American practice, and it is often hard to understand why scaffolds remain standing, instead of collapsing in this way. For the necessary resistance to endwise displacement, builders too frequently depend solely upon the stiffness of the connections between the ledgers and the poles, and this may be wholly inadequate if the load upon the scaffold is more than purely nominal, or if the poles are not straight and truly vertical. To strengthen the scaffold in the direction indicated, a positive and definite provision of

some kind should be made. The spring stays that hold the scaffold to the wall help to a slight extent, but they cannot oppose much resistance to displacement in a direction parallel to the wall.

When the scaffold turns a corner, a considerable amount of stiffness is imparted to it by the fact that it is anchored to the walls in two different directions, at right angles to each other. Window bracing, such as is described in paragraph 48, may be fairly effective for stiffening the scaffold in a direction parallel to the wall, provided the braces that run to the windows are inclined to the wall and run in both directions, as suggested in the closing lines of that paragraph. It is far

FIG. 27. GUARD-RAIL AND FOOT-BOARD ON A BRICKLAYERS' POLE SCAFFOLD IN DRESDEN.

better, however, to provide diagonal bracing to stiffen the poles and prevent collapse by the method under consideration. It will not be necessary to consider the details of this form of bracing in the present paragraph, however, because the subject is treated fully in paragraph 56, to which the reader may refer. The principles there advocated, in connection with the independent scaffold, apply with but little modification to the bricklayers' pole scaffold also.

OTHER SAFETY MEASURES

53. Guard-rails, Foot-boards, etc. These important features receive special consideration in Section VII (page 130), to which reference should be made. Fig. 27 shows the platform of a bricklayers' pole scaffold in Dresden, Germany, and attention is particularly invited to the foot-board at the edge of the platform, and to the hand-rail that is provided at a proper height. This scaffold, which was used for laying the brick wall that is seen on the right, was built for utility rather than for beauty; but it was well designed, and it afforded effective protection for the workmen.

IV. INDEPENDENT POLE SCAFFOLD: AMERICAN PRACTICE.

54. Characteristics of the Independent Scaffold. The independent pole scaffold is closely similar to the bricklayers' pole scaffold, the essential and most obvious point of difference between the two, as the names are used in this treatise, being, as already explained in paragraph 7, that the bricklayers' pole scaffold is partly supported by the wall beside which it stands, while the independent pole scaffold does not rest upon the wall at all, but is supported by *two* rows of poles or uprights, one of which is set near the wall, while the other stands far enough away from it to allow a proper space for the platform.

The independent pole scaffold is also called the "masons' scaffold", because it has long been used in the erection of stone buildings, where it would not be convenient to make places for the putlogs by omitting stones from the walls. The name "independent" that is adopted in this book is greatly to be preferred, however, not only because it is to some extent descriptive of the scaffold, but also because the scaffold is used for a great variety of purposes in addition to mason work. It is extensively employed, for example, in repairing and decorating, and in many other kinds of work in which defacement of the walls must be avoided. It is also growing in favor, quite rapidly, for use in the laying of brick.

When it is to be used for heavy work, the independent pole scaffold is built more substantially than the bricklayers' pole scaffold, and its platform is usually wider. Each set of poles has its own ledgers, and the cross-pieces or "bearers" that support the platform (and which correspond to the "putlogs" of the bricklayers' scaffold) rest upon the inner ledgers exactly as they do upon the outer ones. The inner row of poles is placed near the wall, but space enough must be left behind it to permit the men to work there without inconvenience.

55. Comparison with the Bricklayers' Pole Scaffold. Much that has been said in connection with the bricklayers' scaffold applies to the independent scaffold also. Spruce is strongly recommended for all its parts, and the material should be first-class in all respects,—sound, straight-grained, well-seasoned, and free from knots and all other defects. The footing of the poles should be prepared with even greater care than is needed for the bricklayers' scaffold (compare paragraph 24), because the independent scaffold usually has less support from the building, in the way of bracing, and it is correspondingly more important to give scrupulous attention to its foundations. Independent scaffolds are often erected upon sidewalk sheds, and in such a case the poles of the scaffold should be made to rest solidly upon large cross-beams, and be fastened to them securely. A construction of this type calls for special strength, solidity, and rigidity, in the sidewalk shed.

In the independent scaffold the bearer-bars, upon which the platforms rest (and which correspond to the putlogs of the bricklayers' scaffold), consist of pieces

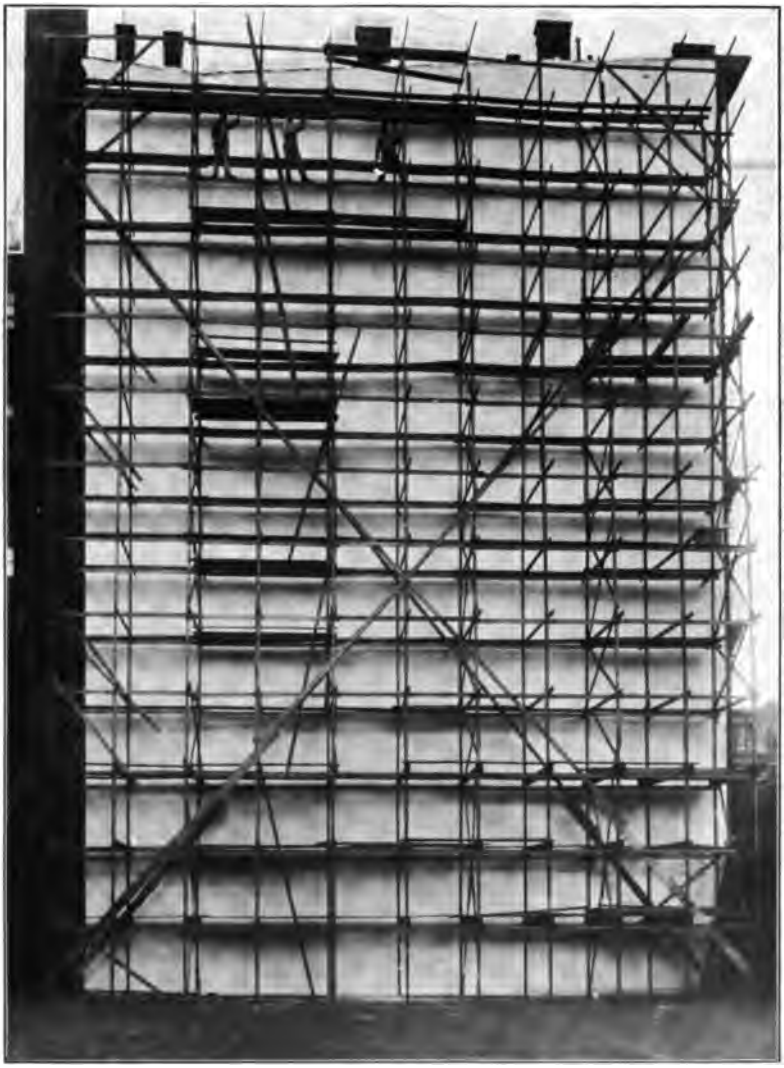

FIG. 28. AN INDEPENDENT POLE SCAFFOLD FOR LIGHT WORK.

(This engraving gives a good idea of the method of construction. The scaffold should have guard-rails and foot-boards, however.)

of plank set upon edge and nailed securely to the uprights in such a way that they rest upon the top edges of the ledgers, both at the front and at the back of the scaffold. If the scaffold is to be used in construction work, the bearers should be made of plank from 1 1/2 in. to 2 in. thick (preferably 2 in.), and every bearer should be secured to two poles,—one at the front of the scaffold and one at the back,—by at least four 20-penny nails at each end. If the scaffold is to be used for wall decoration, or for some other light purpose, it may not be necessary to adopt quite so heavy a type of construction. In fact, the uses of the independent pole scaffold are so varied that it is impossible to give for its parts any one set of dimensions that would be generally applicable. A useful idea of the requirements of sound and safe design can be had, however, from the data given in paragraph 57, below.

Fig. 28 shows a light independent pole scaffold that was erected for cleaning and painting the wall of a building. The general nature of the independent scaffold is shown very well in this illustration, but the actual construction of this particular scaffold is not ideal in every respect,—notably because there are no guard-rails and no foot-boards.

56. Bracing. As the independent pole scaffold receives comparatively little support from the building beside which it stands, it is highly important to strengthen it and stiffen it very thoroughly by systematic and careful bracing.

The inner and outer poles should be connected by diagonal braces, making an angle of about 45 degrees with the ground. (For detailed information see paragraph 57.) For light work it may not be neces-

sary to unite *every* pair of poles in this way, though it is always best to do so. In the scaffold shown in Fig. 28 cross bracing of this kind is provided, as will be seen, for every alternate pair of poles, the intermediate pairs of poles being unbraced.

To stiffen the scaffold and prevent it from collapsing in a direction parallel to the face of the building in the way suggested in Fig. 25, diagonal bracing, making an angle of about 45° with the ground, should be run from pole to pole, parallel to the wall, and be securely fastened to the poles by a sufficient number of stout nails, of the quality indicated in paragraph 79. Particular attention should be given to this longitudinal bracing, because American practice is distinctly poor in this respect, and it is hoped that a marked and universal improvement may soon be made.

Longitudinal braces may extend merely from pole to pole, or they may be run up across the whole face of the scaffold, being lengthened, wherever necessary, by the addition of more pieces running in the same general direction. Numerous examples of each of these methods are to be seen in the illustrations in this book. (See, for instance, Figs. 3, 7, 32, 51, and 63, among others.) Fig. 28 is an example of a scaffold braced by one "*X*" extending across the front of the whole structure, and another one, parallel to the first, extending entirely across the rear face. It is not customary to brace the *inner* poles in this way, in guarding against displacement in a direction parallel to the face of the wall; for although this adds stiffness to the structure, the bracing of the outer row, if it is effectively done, is usually sufficient to strengthen the whole in a satisfactory manner.

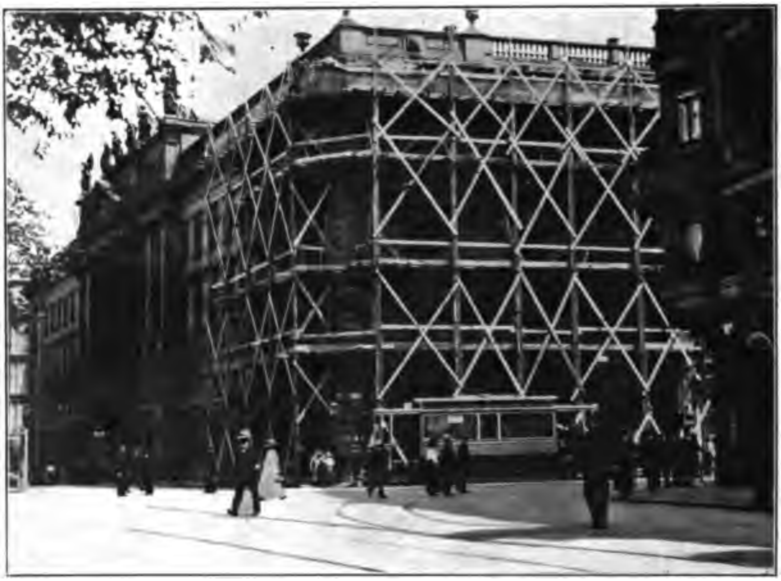

FIG. 29. A SCAFFOLD STIFFENED BY NUMEROUS SHORT BRACES.
(Note, also, the guard-rails and foot-boards.)

When the longitudinal bracing consists of comparatively short pieces of material extending merely from pole to pole, it should be run up the poles like a coarse lattice-work, so as to tie them securely from top to bottom. It is not always necessary to provide such a lattice-work between every pair of poles, although the structure is far safer if this is done. In scaffolds of moderate height, that are not heavily loaded, sufficient stiffness can often be insured by erecting a lattice of the kind described at every other bay,—that is, by uniting the first pole to the second one, the third to the fourth, the fifth to the sixth, and so on.

Fig. 29 shows a well-constructed scaffold that was used on a stone building in Leipzig. Doubled poles were adopted for the uprights, and the longitudinal rigidity

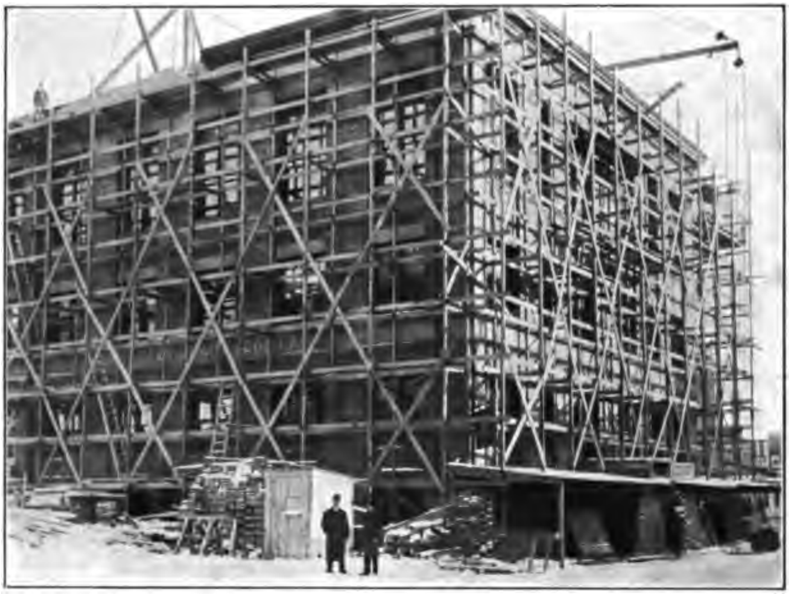

FIG. 30. A WELL-BRACED AMERICAN SCAFFOLD.

was secured, not by running long braces across the entire face of the scaffold, but by uniting every pole with each of its neighbors by means of three pairs of shorter braces. The guard-rails and foot-boards of this scaffold should also be noted, as they were installed in a highly creditable and workmanlike manner, and might well serve as models for American constructors.

Fig. 30 shows a well-braced independent scaffold that was used in the erection of a brick building in Massachusetts. As will be seen, this scaffold is stiffened by long longitudinal braces, each running across several poles; and in this respect it contrasts with the method of bracing that is shown in Fig. 29. Fig. 30 is an excellent example of bracing, yet the bracing shown in Fig. 29 is probably more effective, because in that con-

struction every bay between consecutive poles is fully braced, whereas in Fig. 30 some of the poles are united by only a single pair of braces.

In any case, whether the bracing has the form of an "*X*" or consists of lattice-work extending merely from one pole to the next, the constituent pieces composing it should run in both directions, so that the scaffold may be efficiently braced against falling either way. When long poles or stringers are used and arranged like an "*X*", they should be securely nailed or lashed to every pole that they cross.

57. Design for an Independent Pole Scaffold. The design shown in Fig. 31 will be found to be serviceable and safe, for pole scaffolds not exceeding 100 feet in height, when used in construction work, with ordinary loads. It is based upon extensive experience, and the proportions that are indicated have been thoroughly tried out in practice, and found to be satisfactory for service of this kind; but if the scaffold is to support loads of greater weight than are likely to occur in ordinary building operations, the various parts should be proportionately strengthened. The workmanship should be of the best, in all respects, and the scaffold should be constructed, throughout, of spruce or of long-leaf southern pine. The material should be carefully selected, and every part of it should be sound, straight, straight-grained, free from knots and all other imperfections, and thoroughly seasoned.

When a scaffold is unusually high, or is to be heavily loaded, it is advisable to bolt its parts together. Nails are used almost exclusively in American practice, however, and for that reason we assume, in what follows, that the scaffold is nailed and not bolted. Nails

are quite satisfactory under ordinary conditions, but it is highly important to use them in sufficient numbers, to have them of the right size, and to see that they are properly distributed, and that they are of the quality indicated in paragraph 79.

The poles, *A*, in Fig. 31, should not be less than 4 inches by 4 inches, and 6 inches by 6 inches is a much better size, and greatly to be preferred. Where an upright is spliced, as at *B*, the two poles that are to be joined should be sawed off truly square, and the upper one should be set upon the lower one so that their ends will match accurately. Cover-strips, not less than 36 inches long and 1 1/4 inches thick, and equal in width to the respective sides of the poles to which they are applied, should be nailed to the upright at each splice, on two sides of it that are at right angles to each other. Care should be taken to see that the middle point of each strip comes opposite the splice in the upright, and each strip should be securely nailed to the upright with not less than ten well-distributed 20-penny nails, five of which should be above the splice, and five below it. The uprights should be truly vertical, and great care should be taken to have their foundations secure and safe in every respect. (See paragraphs 24, 25, and 55.) The splices of successive poles should not come opposite one another, if this can be conveniently avoided.

The spacing of the poles will depend, to a considerable extent, upon the load that is to be borne. They should not be set more than 10 feet apart (measuring from center to center), in a direction parallel to the face of the wall. This is ordinarily regarded as good practice, when the other parts of the scaffold have the

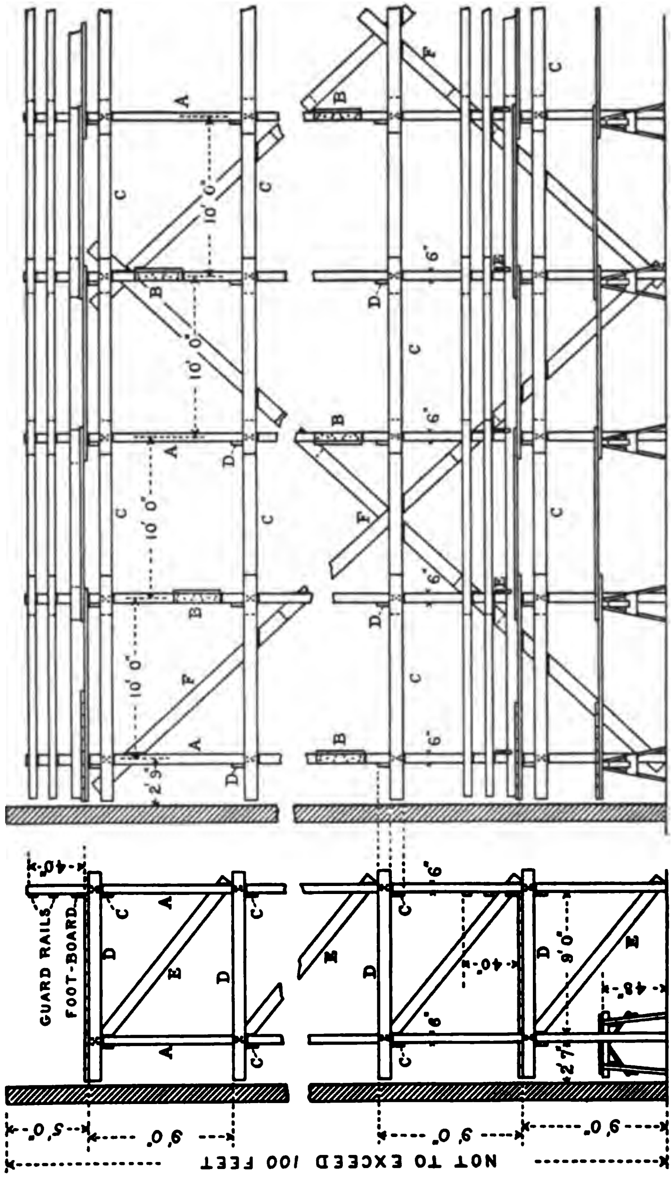

FIG. 31. DESIGN FOR AN INDEPENDENT POLE SCAFFOLD FOR CONSTRUCTION WORK.
(For dimensions and general discussion, see pages 90 to 98.)

sizes suggested in this section; but the uprights should be set *closer* than this if the load is likely to be unusually heavy, and it is sometimes advisable to place them as close as 5 feet from center to center.

The outer row of poles should be about 9 feet from the inner row; and as it is important for the scaffold to have a base wide enough to insure stability, this distance should not be reduced, even under heavy loading;—the increased strength that is called for under these circumstances being obtained by other means.

The inner row of poles should be set from 24 to 36 inches from the wall, not only to allow for irregularities in the wall where ornamental or other projections exist, but also to give the workmen a freer access to the wall than could be had if the poles were practically in contact with it.

The ledgers or "running strips", *C*, should be at least 9 inches by 1 1/4 inches, and should be nailed to each pole with at least five 20-penny nails. The vertical height from the top of one ledger to the top of the next will depend somewhat upon the nature of the work, but an interval of from eight feet to nine feet is most convenient under ordinary circumstances. Ledgers should never be spliced between the poles. They should always be long enough to extend from pole to pole, with an overlap of at least a foot at each pole; and in nailing a ledger to the pole, care should be taken to keep the nails well away from the top edge of it, lest the load upon the ledger cause it to split.

The bearers, *D* (also called "bearer-bars" or "cross-bars"), which correspond to the putlogs of the bricklayers' pole scaffold, consist of planks set upon edge. They rest upon the ledgers, and are also nailed to the

poles. Bearers should not be less than two inches thick and nine inches wide, and they should be secured to the poles by not less than five 20-penny nails at each end. On the side of the scaffold furthest from the wall, the bearers usually project beyond the poles, to a distance of one foot or more, and on the side toward the wall they are usually allowed to project sufficiently to come almost into contact with the wall.

The cross-braces, shown at *E* in Fig 31, should be not less than nine inches wide and one and one-fourth inches thick. They should be arranged as shown, and should be secured to the poles by not less than four 20-penny nails at each end. Every pole in the front row should be connected to the pole opposite to it in the back row by at least one brace of this kind between every pair of ledgers, as indicated in the engraving. When the scaffold is to be used for very heavy work, it may be advisable to have these cross-braces run in both directions, instead of only in a single direction; but for ordinary loads the bracing here shown should be adequate, if the scaffold is designed and constructed in other respects in conformity with the suggestions in this section. The use of double braces, running both ways like the two branches of an "*X*", makes it somewhat inconvenient for the workmen to pass from one part of the scaffold to another, along platforms where this double bracing occurs. At the free end of the scaffold, however, the cross-bracing should run in both directions, because considerable additional strength is secured by this construction, and the "*X*" is not in the way of the workmen at the end of the platform.

The longitudinal braces, indicated at *F* in the engraving, are highly important, and careful attention

should be paid to what has been said with regard to them in paragraph 56. These braces should be not less than 1 1/4 inches thick, and 8 or 9 inches wide. They may be simply run from one pole to the next, in accordance with the scheme shown in Fig. 29, or they may be extended across the entire face of the scaffold, somewhat as suggested in Fig. 30. If the method shown in Fig. 29 is adopted, there is but little further explanation to be given, except to caution the builder that the nailing should be good, and the nails ample in size, and (as is assumed throughout the book) of the quality indicated in paragraph 79. If the method of arrangement shown in Fig. 30 is adopted, a few further words of counsel should be given. In this case the braces should be securely nailed to every pole that they cross, with at least five 20-penny nails to the pole. The splicing of the longitudinal braces between poles should be avoided so far as possible, and when it becomes necessary to splice them in that way the two ends should overlap by at least four feet, and should be nailed together with not less than five well-distributed 20-penny nails. A scaffold that is properly constructed, and built of selected materials in conformity with the suggestions of this section, should not need more longitudinal bracing than is shown in Fig. 30. That is, when the poles are spaced ten feet apart, it should be sufficient to start one longitudinal brace at the foot of every second pole, extending it upward at an angle of about 45° to the top of the scaffold. The longitudinal braces should run in both directions, however, as indicated in Fig. 30.

On the outer row of poles, the ledgers may be attached, most conveniently, to the side of the poles

that is nearest to the wall, and the longitudinal bracing can then be applied on the side that is away from the wall. It is not customary to run longitudinal braces along the *inner* row of poles, because they interfere with the work, and experience shows that sufficient stiffness may be had from those on the face of the scaffold.

With a construction such as has been recommended above, a platform may be laid on any set of bearer-bars, and the number of platforms that are used will naturally depend upon the nature of the work that is to be done. It is advisable to lay an extra platform immediately over every level on which men are working, to protect them from the fall of tools or materials from above. It is also advisable to lay a platform on every third set of bearer-bars, in all cases, in order to lessen the seriousness of accidents that may occur by the falling of men who are at work about the scaffold. Every platform should be made of two-inch planks, laid tight together so that nothing can fall down between them, and disposed so that they will overlap the bearer-bars by the same amount at each end. When the poles are spaced, parallel to the wall, at a distance of ten feet from center to center, and the planks that are used are twelve feet long, this will allow each plank to overlap the center of each bearer-bar by one foot, so that the successive courses of planks will overlap each other by *two* feet at each bearer-bar. This should be sufficient to insure safety. If the poles are spaced closer than ten feet from center to center, twelve-foot planks may also be used, and allowed to overlap to a correspondingly greater extent; but in this case special care should be taken to see that no plank is left with its free end extending more than about one foot beyond a bearer-

bar or other safe and solid support. This is to avoid danger from the tipping of the plank, in case a workman should happen to step upon the end of it, or deposit material upon it.

When an independent pole scaffold is designed as suggested in this section, the interval between the bearer-bars is so great that it is impossible for the men to work on the wall from the level of one of them up to that of the next one above, while standing directly upon one of the permanent platforms. A single tier of horses is therefore used, as indicated in the illustration, to enable the men to reach the upper part of this interval. For counsel with regard to horses, see Section IX, page 153.

For security against displacement by settling, or by storms, a scaffold of the kind here described should be securely attached to the wall of the building, at or near the top, when this wall is already standing. If the wall is not yet built, some other means of insuring stability should be provided. It commonly happens that the scaffold turns one or more corners, and in such a case sufficient security may be afforded by the shape of the scaffold itself, if it is solidly built in accordance with the suggestions herein made. It is impossible to discuss every condition that may arise, but special attention should be given to the stability of the scaffold as a whole, and effective measures of some kind should be taken to insure that stability, so that the structure cannot fall over bodily.

For gaining access to the different levels of the scaffold, it is strongly recommended that stairways be built within the framework, these stairways being provided with substantial hand-rails, as suggested in

paragraph 78. If ladders are used, the recommendations in paragraph 76 should be carefully observed. It is best to run the ladders inside the framework of the scaffold, and the openings where they come up through the flooring should be guarded by rails and foot-boards.

58. Guard-rails, Foot-boards, etc. At every working platform on the scaffold, guard-rails and foot-boards should be provided, in accordance with the recommendations made in Section VII, page 130. Special attention should be paid to these features, because American practice is commonly poor in this respect, and the tendency of our builders is to omit these important safeguards entirely, or to treat them altogether inadequately. The use of wire netting is also strongly advised, for it is far more practical on independent scaffolds than it is on scaffolds of the bricklayers' type. (Compare paragraph 130.)

V. LASHED SCAFFOLDS.

59. Characteristics of the Lashed Scaffold. In Great Britain, and in Europe generally, the various parts of scaffolds are frequently secured in place by ropes, chains, or flexible metallic cords; and as it is convenient to have a definite, all-inclusive name for scaffolds that are erected in this way, we shall call them all "lashed scaffolds". Scaffolds of this kind were extensively used in the United States, in former times, but American practice has tended away from this method of construction, and lashed scaffolds are now rarely seen in this country. They are not actually obsolete, but they are so uncommon that many of our scaffold builders no longer know how to apply the rope fastenings, so as to insure safety.

When round wood of large size is used in the construction of the scaffold (see paragraph 60), it is almost necessary to lash, clamp, or bolt the parts together, because nails are hardly applicable in this case; and even when sawed material is employed, the use of rope is favored by some authorities on the ground that the material is serviceable for a much longer time if it is lashed together, than it is when nails are used. The damage to the wooden parts, from the use of nails, is not confined to the holes that are made in driving the nails when the scaffold is first erected;—it arises largely from the splitting of the various parts when the scaffold is taken down, after it has served its purpose.

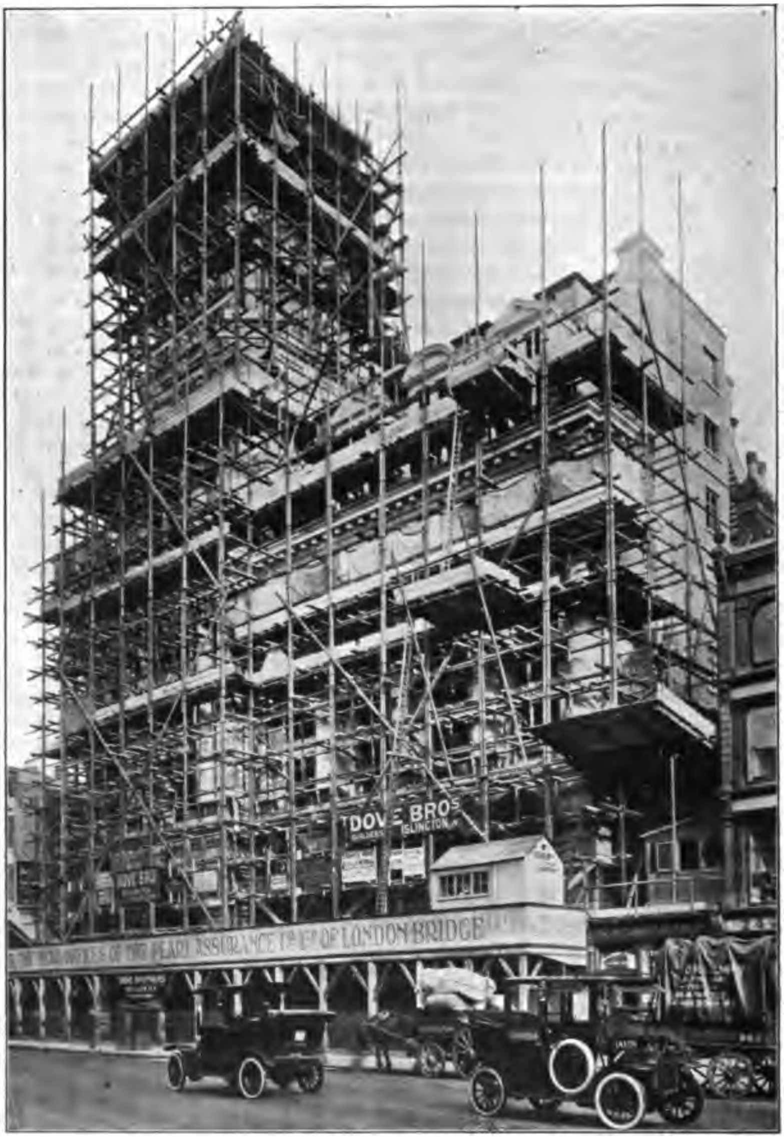

FIG. 32. AN ENGLISH LASHED SCAFFOLD.
(Note the protective platforms, the bracing, and the treatment of the ladders.)

Some authorities believe that American builders will return to the lashed scaffold, after a time, in consequence of the increasing price of lumber; but others assert that this is not probable, or that at all events it will not come to pass for many years,—partly because the material deteriorates to a considerable extent from the effects of the sun and weather, even when nails are not used, and partly because the saving in labor that results from the use of nails is marked enough to counteract a considerable further advance in the cost of lumber. For the proper erection of a scaffold that is lashed with rope, the full time of two men is required, with occasional help from a third; whereas by using nails a bricklayers' pole scaffold can be erected by one man, with occasional help from a second one in getting the uprights into position and in some few other operations.

When rope is used for securing the parts of a scaffold, it is extremely important that the lashing should be done by a person skilled in this particular kind of work. If fiber rope is used, it should be manila (not sisal), and it should be first-class in quality. If there is any doubt about its condition, it should either be rejected, or be tested to see that it has the proper strength. Rope should never be used after it has become seriously weakened by exposure to the weather, and all condemned rope should be destroyed, so that it cannot possibly be used again, either by accident or by design.

The rope employed in lashing ledger poles to uprights is usually about 5/8 of an inch in diameter, or a little less. In New York City, 18-thread tarred ratline (which is a little more than half an inch in diameter) is usually employed for this purpose.

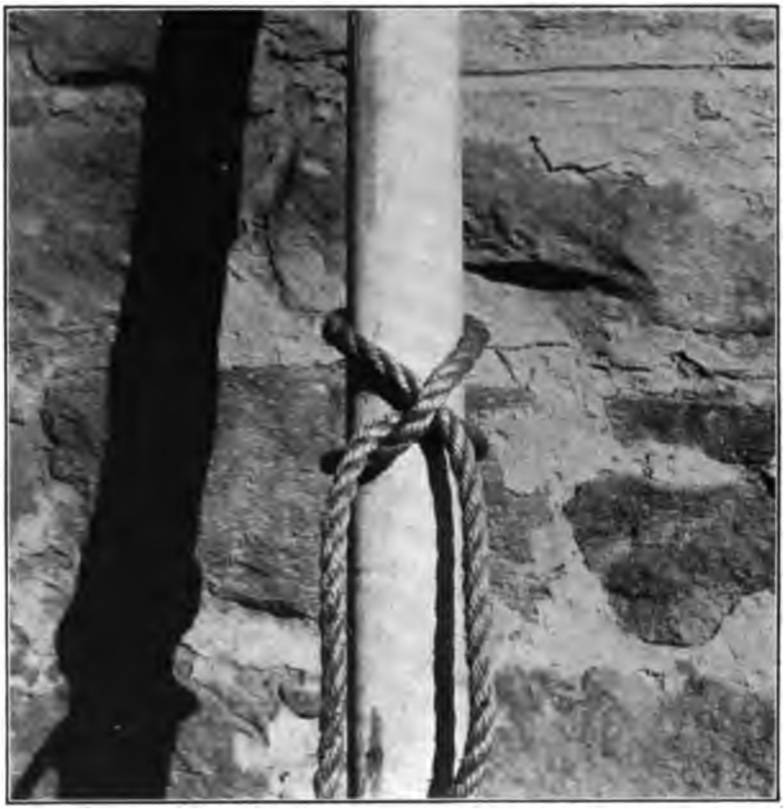

FIG. 33. FIRST STAGE IN LASHING A LEDGER TO A POLE.

60. Use of Round Wood. In Europe, the poles and ledgers of scaffolds are usually made of round wood, consisting of straight sticks from which the bark has been peeled, but which are otherwise left substantially as they grew. Wood of this nature is stronger than sawed material of the same size and quality, because in a sawed piece the grain seldom or never runs exactly parallel to the length of the stick, but often runs somewhat diagonally or obliquely to it, in places. The

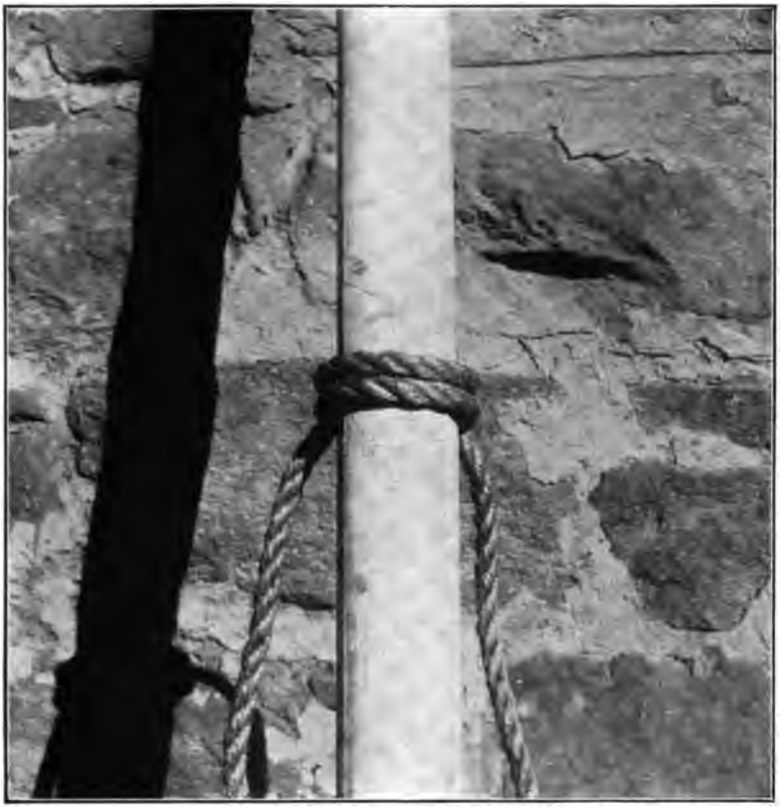

Fig. 34. Rear View of Fig. 33, after Tightening the Knot.

fibers of the sawed pieces are therefore severed, here and there; whereas by making use of selected natural sticks, material can be had, every fiber of which runs without interruption from one end to the other.

In the United States round wood is seldom used in bricklayers' or independent pole scaffolds, the ledgers, putlogs, and uprights being composed, almost invariably, of sawed timber; but round wood is used here to a limited extent in certain other forms of

FIG. 35. FIRST STAGE IN SECURING THE LEDGER.

scaffolds, particularly when the conditions are such that it is desirable to exercise extraordinary care to insure an unusually large factor of safety. For example, the stringers that supported the overhead platform of the decorators' scaffold in the Grand Central Terminal, New York City, and which may be seen just below the ceiling in the photograph that constitutes the frontispiece of this book, were made of selected natural wood, round, and untouched by a saw except where they were squared up at the ends.

FIG. 36. FINISHED KNOT AS SEEN FROM THE FRONT.

61. Tying the Knots. When a ledger is to be erected, the ropes that are to be used for the purpose should first be tied to the uprights, in the position that they are to have when the task is completed. Each rope should be at least seven or eight feet long, and the knot that secures it to the upright should be in the middle of its length.

Fig. 33 shows how the rope should be arranged upon the pole,—the knot or hitch being left loose, in

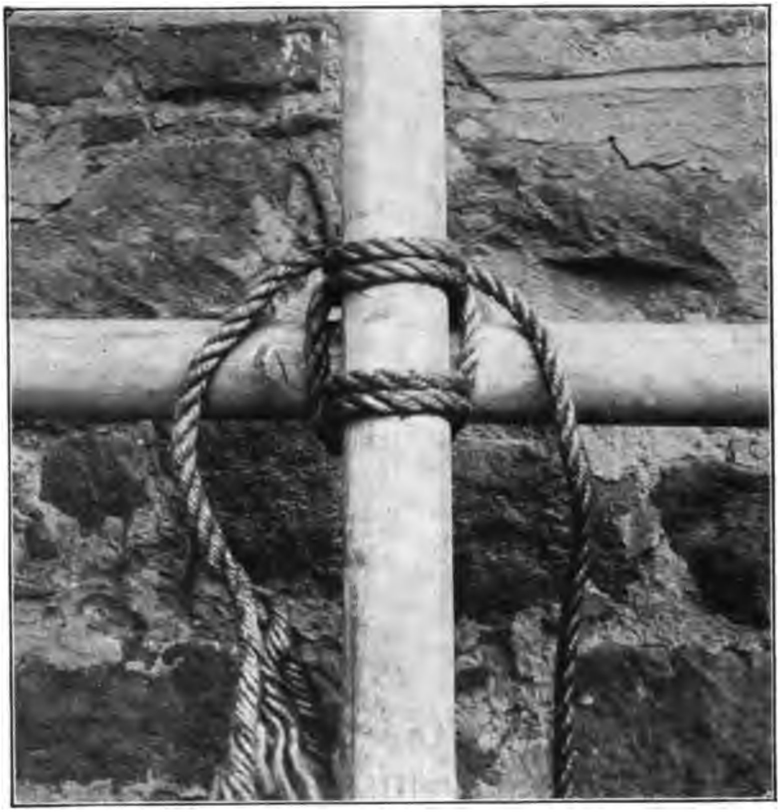

FIG. 37. FINISHED KNOT AS SEEN FROM BEHIND.

taking this photograph, so that the relations between its various parts may be clearly seen. The appearance of the rope when it is viewed from the back of the pole at this stage is shown in Fig. 34, except that the loops or turns of the rope have now been pushed together, and the hitch properly tightened up.

The ledger pole is next laid against the upright, with its lower side just on a level with the upper part of the rope in the hitch. Each end of the rope is then

carried up around the ledger pole, then back around the upright, and finally forward again and down over the front of the ledger. This brings the knot into the condition shown in Fig. 35. The two ends, seen depending in this illustration, are then *crossed* in front of the ledger, and passed under it and up behind it, after which they are tied in a square knot, over the ledger and in front of the upright. Fig. 36 shows the completed knot as seen from the front side, and Fig. 37 shows how it appears from behind.

A knot tied as here described will hold the ledger to the upright under the heaviest loads that the rope can bear, and it should never slip if the work has been carefully done. Attention is particularly called to the way in which the ropes lie over one another, beneath the ledger in Fig. 36, because this arrangement causes the parts of the rope to bind against themselves and against the pole, in such a way that they become tighter and hold more securely as the load increases.

In fastening a ledger in this way, all parts of the rope should be drawn as tight as possible; and in tying the final knot, special care should be taken to see that it is a true *square knot*, instead of being what is known among sailors as a "granny knot".

When two ledger poles come together at one upright, the knot is to be tied precisely as described above, except that the two ledger poles are to be laid one over the other, and the rope is to be passed around them as though they constituted one piece.

62. Splicing the Uprights. When rope is used for fastening the parts of a scaffold together, and the uprights are single (instead of being *doubled* as they are in the high scaffold shown in Fig. 32), it is customary to

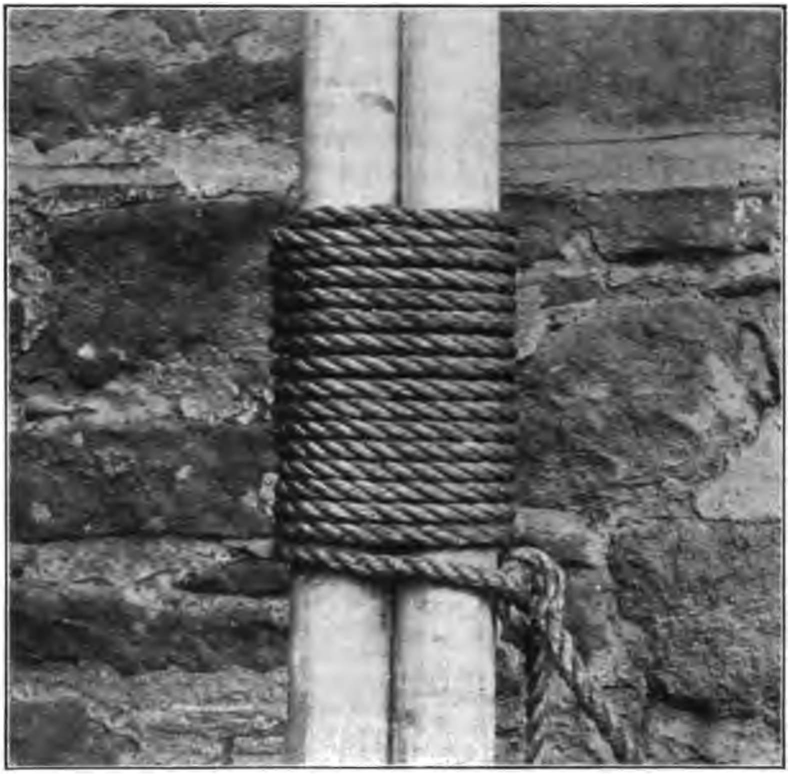

FIG. 38. ILLUSTRATING THE LASHING OF THE POLES.

splice the uprights—*not* by placing each pole squarely upon the top of the one immediately below, as in this country,—but by making the successive uprights overlap by from six to ten feet, and lashing them together with rope. A stout block of wood should be nailed to the lower pole, to assist in the support of the upper one.

In fastening two overlapping poles together with rope, it is customary to lash them in two places, one near the top of the lower pole and the other near the bottom of the upper pole. The poles that are employed

for the uprights of lashed scaffolds are usually about 30 feet long; whereas in the scaffolds that are constructed of sawed material, in this country, the individual poles are seldom much more than 20 feet long.

In lashing a pair of poles together, one end of the rope is passed around the two, near the upper end of the splice, and allowed to hang down in a nearly vertical position for perhaps four or five feet. It should not be allowed to lie entirely within the angle between the two poles, but should be kept out of this depression, so that the next operation will bind it down to the poles as effectively as possible.

The long end of the rope is now wound around the poles as tightly as possible, so that each turn of the rope bears closely against the preceding one, as indicated in Fig. 38. When the lashing has attained a total length of 18 inches or more, according to the load that is to be supported, the two ends of the rope are tied together, as firmly as possible, by a square knot. The operation just described is then repeated with another piece of rope near the remaining free end of the splice, the final appearance being indicated in Fig. 39.

When two sets of poles, lashed together, are used for the uprights for the purpose of securing greater strength and stiffness, the splices in each set are made to come as nearly as possible opposite to the middle portions of the poles of the other set. In extending the poles of uprights that are doubled in this way, each pole is made to rest squarely upon the end of the one next below, and at every splice the upper and lower poles that there come together are each bound to the adjoining pole by a lashing similar to that shown in Fig. 38. (We are here assuming that the fastening is

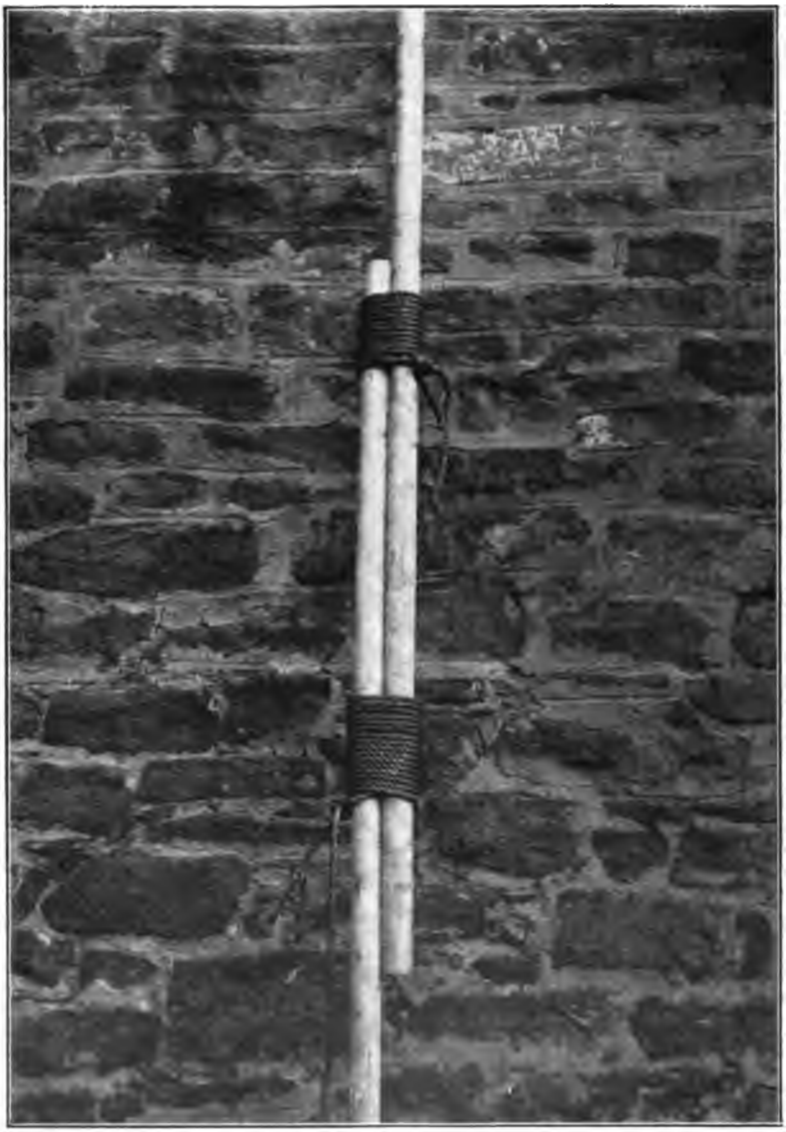

FIG. 39. SHOWING A PAIR OF POLES LASHED TOGETHER IN TWO PLACES.

(A block should be nailed to the lower pole, immediately below the end of the upper one, to make the support more effective.)

FIG. 40. DETAIL VIEW OF A SWISS SCAFFOLD, ILLUSTRATING THE TREATMENT OF THE POLES.

effected by ropes. For data respecting the use of chains, wire cords, clamps, and cramp-irons, see the three following paragraphs.) Fig. 40, which is a detail view of a scaffold in Zurich, Switzerland, illustrates this construction fairly well. Each upright here consisted, at its lower end, of three poles, united by wire cords and also by cramp-irons. At higher elevations the number of poles to an upright was reduced to two,

and at the top a single pole was used. It can be seen, in a number of places, that the ledger poles were not merely lashed to the uprights, but that a more effective support was provided by cutting one of the constituents of each upright to lengths equal to the vertical distance from one ledger to the next. Each ledger rested upon the end of one of these short poles, and supported, in its turn, the pole next above. (This scaffold is far from being a model one in other respects, for it had neither hand-rails nor foot-boards. Moreover, the diagonal bracing was not fastened to the

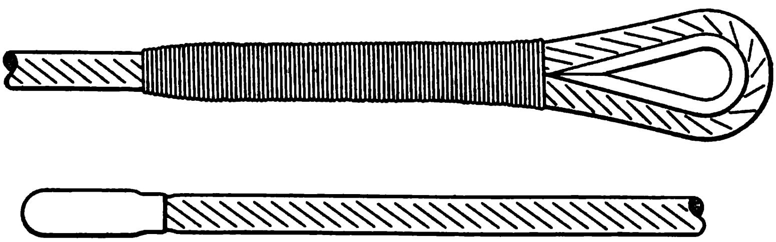

FIG. 41. ILLUSTRATING THE PROPER FINISH OF THE ENDS OF WIRE CORD LASHINGS.

uprights with a degree of security that an American engineer would deem to be sufficient.)

63. Use of Wire Cords for Lashing. Flexible wire cords are used to a considerable extent for lashing the parts of scaffolds together. The cords that are used are about 1/4 in. in diameter, as a rule, and they are made long enough to wrap quite a number of times around the timbers that are to be united, so as to insure strength. Each cord should be provided at one end with a thimble-like cap for receiving the wires and keeping the end of the cord in good condition, and at the other end it should be provided with an eye, which

FIG. 42. SCAFFOLD POLES UNITED BY WIRE CORDS AND A CHAIN.

should be spliced into the cord in a thoroughly workmanlike manner. When uprights or other parts have been lashed together with a cord of this kind, the thimbled end of the cord is passed through the eye at the opposite end, and secured as effectively as possible, by winding it about the strands that have already been wrapped around the poles. A fastening of this kind is quite effective. It is easily applied, and it is not likely to fail if the cords are renewed from time to time, when their strands become worn, strained, or broken, in service.

Fig. 41 illustrates the way in which the ends of a wire cord should be finished, for use in lashing a scaffold, and Fig. 42, which is taken from a London scaffold, shows four large poles (two of which are diagonal braces) lashed together by wire cord. Two of the poles are also united by chains, as explained in the next paragraph.

64. Use of Chains. Chains are also used for fastening the parts of heavy scaffolds together, and very effective connections can be made in this way.

In using lashings of any kind it is essential to draw them as tight as possible, so that they will bind the parts together firmly and solidly. For tightening chain connections the device shown in Figs. 42, 43, and 44 is sometimes used. This is placed against the pole or ledger as shown in Fig. 42, a small projection from the center of its base (not visible in the engravings) penetrating the pole by perhaps 3/8 of an inch, and serving to prevent the device from shifting its position

FIG. 43. CHAIN-TIGHTENING DEVICE: APPEARANCE WHEN THE CHAIN IS SLACK.

FIG. 44. CHAIN-TIGHTENING DEVICE: APPEARANCE WHEN THE CHAIN IS TIGHT.

when it is once firmly in place. (The movable part of the device, at this stage, is screwed down into the position shown in Fig. 43.) The chain is then drawn around the poles as tightly as possible, and hooked over two of the projecting ears that are shown in Figs. 43 and 44. The central nut of the device is then turned to the left, so as to carry the ears away from the pole, as suggested in Fig. 44,—the nut being capable of turning freely without causing the ears to revolve at the same time. By this means the chain can be drawn tight enough to cause it to sink into the wood of the poles to an appreciable extent.

The device here described is excellent in theory, but it is usually made of cast iron, and the ears sometimes break off under the stress that is thrown upon them. We therefore do not recommend it unless it is made of safer material, and even then we prefer to secure the chain in some other way, unless the location of the connection is such that no great harm would be likely to result from its failure. Moreover, we consider chains to be distinctly inferior, in any event, to high-grade wire rope or cord.

65. Use of Clamps and Cramp-irons. Clamps of many kinds are used, particularly in Europe, for supporting ledgers and securing them to the uprights. One of the forms that are adapted to American practice, and used here to some extent, is shown on page 54. Most of the clamps that have been devised are intended for use in connection with ledgers of round wood, however, and as such ledgers are not commonly employed in the United States, and are not likely to come into general use in the near future, it does not appear to be necessary to discuss the various special clamps that are made for supporting them.

Cramp-irons or "dogs", of the form shown in Fig. 45, are extensively used in scaffold construction throughout Europe, and they are seen to some slight extent in this country also. The iron that is represented in Fig. 45, is about 10 in. long, and the body of it is 7/8 in. wide and 5/16 in. thick. The points are forged up at the ends, and are about 2 5/8 in. long. In a new iron the points stand nearly at right angles to the body, but they should flare outward to a slight extent, so that when they are driven in, they will draw the parts that they enter more closely together. The illustration was made from an old specimen that

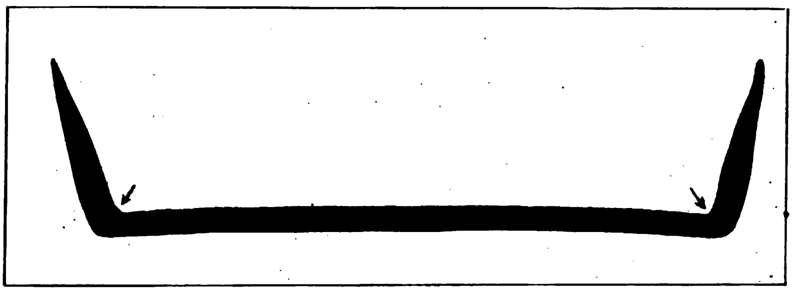

FIG. 45. A CRAMP-IRON.
(Overstrained by use, and cracked where indicated by the arrows.)

had seen considerable service. The points, as will be seen, had become bent outward to a considerable extent, and a well-defined crack had also developed, at each end, in the angles where the points join the body. If cramp-irons of this kind are employed, they should be carefully forged up from first-class material, possessing a high degree of ductility.

A good idea of the way in which these irons are used can be had from the accompanying illustrations, which show them in a number of different applications. They

FIG. 46. CRAMP-IRONS SUPPORTING A HORIZONTAL BRACE.

are used not only for uniting the various parts of the scaffold, but also to steady ladders, and to afford points of support for pieces under which cleats or blocks would be placed in American practice. With all due deference to the opinions of European engineers, however, we prefer, in most cases, a more positive form of connection than is afforded by cramp-irons of this nature.

Fig. 46 shows three of the irons in use for securing a horizontal brace to a ladder. The ladder in this case was made stout enough to serve as a support to the scaffold. (A better idea of the general nature of the scaf-

fold of which this is a detail can be had from Fig. 53, where each of the uprights consists of a similar ladder.) The method here shown for securing the brace does not commend itself to American safety engineers, unless it is supplemented by some other mode of attachment. It will be seen that one iron is driven into the ladder at both ends, below the horizontal stringer, to serve as a point of support for it; and if this iron should fail, the brace would be likely to fall by revolving in the direction of the hands of a clock, and thereby tearing itself loose from the two irons that support it from above.

FIG. 47. CRAMP-IRONS AS APPLIED AROUND THE FOOT OF A SCAFFOLD UPRIGHT.

Fig. 47 shows a number of irons applied to hold various parts of a scaffold together, around the base of one of the vertical supports. Although the photograph does not show the fact as clearly as could be wished, the upright was composed of two poles, and the two uppermost irons on the front of the scaffold are driven in so that they serve to hold these two poles together.

66. Bracing. The principles that underlie the bracing of lashed scaffolds are in no way different from those that relate to the independent pole scaffold, as described in paragraph 56. The differences in practice that exist relate merely to the methods by which the braces are secured to the other parts of the structure, and these have been described in the last few paragraphs.

67. Guard-rails, Foot-boards, etc. These important safety features are considered in Section VII, page 130, to which reference should be made.

VI. OTHER FORMS OF POLE SCAFFOLDS.

68. Pole Scaffolds with Iron Supports. A form of scaffold that is used by bricklayers to a limited extent, and which is analogous to the bricklayers' pole scaffold described in Section III (page 38), is shown in Fig. 48. In this construction the uprights consist of angle-irons of special form, one of which is shown in the upper part of Fig. 49. The uprights sometimes rest upon the ground, and sometimes, as an alternative construction, they are supported by iron brackets, as indicated in Figs. 48 and 50. Each upright that rests upon the ground is provided with a special foot like

FIG. 48. BRICKLAYERS' SCAFFOLD WITH IRON SUPPORTS.

that shown in Fig. 49, consisting of a circular iron plate about 18 inches in diameter, which is dished at the edges and provided with gusset-like ribs or braces.

Fig. 50 gives a detailed view of the brackets that are used on this scaffold, when it is not convenient to have the uprights bear directly upon the ground. The horizontal arms of these brackets are attached to ears that are built into the wall, and the brackets are prevented from swinging sidewise by stay-rods extending from their outer extremities to other ears that are also built into the wall, and provided with turn-

FIG. 49. FOOT OF IRON POLE.

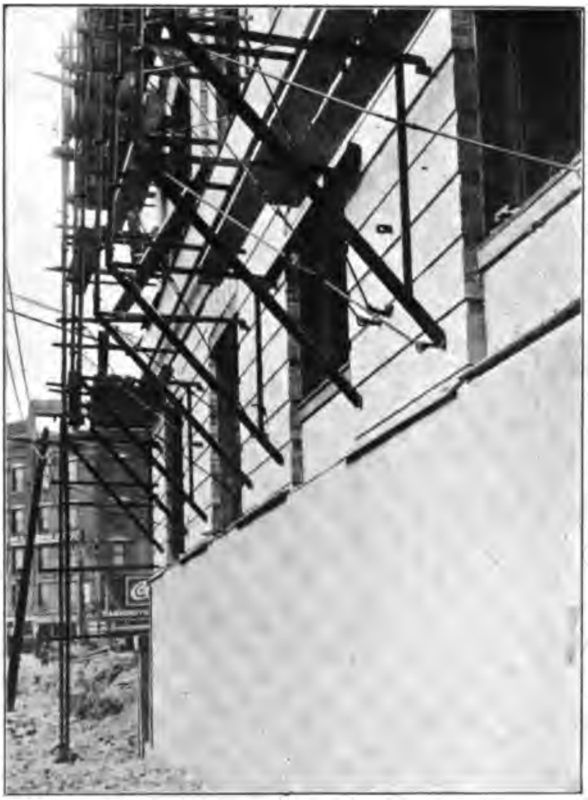

FIG. 50. IRON BRACKETS FOR BRICKLAYERS' SCAFFOLD.

buckles by which they can be tightened. It is important to have the stay-rods as nearly horizontal as possible, instead of inclining them downward as shown in the engravings; because when they are horizontal they afford additional security against the overturning of the brackets by the weight that rests upon them, whereas if they are put in so that the ears to which they are attached are nearly on a level with the feet of the braces, they afford no support of this kind, whatsoever. The various parts of the scaffold are held together by special

clamps, which are designed for the purpose and furnished by the makers of the scaffold.

The use of this scaffold is quite limited in the United States, although in a slightly different form it has been employed in England for a number of years. When the structure is erected by the use of brackets, its safety depends altogether upon the security with which the ears that hold the brackets and their stay-rods are built into the wall. The most scrupulous attention should therefore be paid to this point, and special care should also be taken to prevent the workmen from loading the platform with any considerable weight of material.

69. Ladder Scaffolds. In many parts of Europe a convenient and useful form of light scaffolding is extensively used, which is seldom or never seen in the United States. We refer to the "ladder scaffold", which takes its name from the fact that it is supported by vertical ladders of a somewhat special form, instead of by simple poles. The ladders are set upon end, and their rungs support horizontal planks which serve as platforms. The side-bars of the ladders play the part of the poles of the independent scaffold, and the rungs that support the planks play the part of bearer-bars or putlogs. The construction will be clearly understood by referring to Figs. 51 and 52, which show two slightly different forms of the ladder scaffold.

These scaffolds are often extended to great heights, but as ordinarily constructed they are not adapted to heavy work, nor to the support of materials. They are exceedingly useful, however, for light work, such as cleaning walls, painting, and making general repairs; and when they are made strongly and in accordance

with special designs, and are erected by men skilled in this kind of service, they are used in construction work also.

To protect the workmen from falling, ladder scaffolds should be provided with guard-rails at least 6 in. wide and 1 in. thick, as shown in the illustrations. (The man directly under the cross in Fig. 51, for example, is leaning upon one of the guard-rails.) They are rarely fitted with foot-boards, because they are not supposed to be used for the support of materials; but the heavier scaffolds of this type are likely to have tools and a certain amount of materials upon their platforms, and in such cases foot-boards should always be provided.

To facilitate passing along the plank platforms from one part of the scaffold to another at the same level, rungs are often omitted from the ladder at intervals. An example of this is shown in Fig. 52, where spaces for the passage of the men are provided by omitting the second rung above each line of planks. The openings thus made are usually about 36 in. high and perhaps 20 in. wide.

Ladder scaffolds should be securely attached to the building at every story, either by braces passing through the window openings, or by lashings made fast to ears or eyes that are secured to the walls in some safe manner; and the height from one such brace or lashing to the next should never exceed 20 feet. The scaffold should also be effectively stiffened by diagonal bracing, similar to that described in paragraph 56 in connection with the independent pole scaffold that is used in the United States. (See Fig. 51.)

The German regulations that apply to these scaffolds specify that the ladders must not rest directly

upon the ground or sidewalk, but require that every ladder shall stand upon pieces of plank so placed that the two side-bars will bear upon them equally, and with their full load. It is further specified that the ladders shall not be more than 12 feet apart, and that any blocking-up that may be necessary shall be effected only by the use of broad wooden wedges,—the use of

FIG. 51. A LADDER SCAFFOLD, FOR LIGHT WORK.

stone or iron for this purpose being expressly forbidden, —and that the wedges shall be effectively fastened in place.

To extend the ladders in a vertical direction, the upper ladder is spliced to the one below by overlapping the two and connecting them by hooks if the scaffold is a light one, or by splice-plates and bolts if it is intended for heavier work. Where these connections are made, the ladders have iron bolts in the place of rungs, to receive the hooks or splice-plates; and the German regulations specify that these bolts shall not be less than one inch in diameter.

The workmen should not climb up by the ladders that serve to support the scaffold. Access to the various platforms should be had from the building itself, or by the use of ladders of the ordinary form, specially provided for this purpose. Ladders for climbing should be located within the framework of the scaffold whenever possible, so that the workmen, in using them, may have the protection of the guard-rails at the various platform levels. (An external ladder, provided for the ascent of the workmen, is shown at *A* in Fig. 51.)

The platform planks should be at least 1 1/2 inches thick, and when a platform consists of two courses of plank laid side by side, the two courses should be connected, at the middle of each span, by a clamp or stirrup that embraces both planks and holds them securely together. Several of these stirrups can be seen, though somewhat imperfectly, in Fig. 52.

The most distinctive thing about the ladder scaffold is the fact that it is built so that it can be erected and taken down again, without damage, and can there-

fore be used repeatedly. The entire scaffold is made adjustable, each guard-rail and brace being provided with a series of holes at one end and with a slot at the other, so that it can be bolted to the ladders, wherever these may stand.

Scaffolds of this type are owned by companies that lease them to the users, the rental covering the work of erection and removal, which is performed by

FIG. 52. A LADDER SCAFFOLD, DIFFERING SLIGHTLY IN DESIGN FROM FIG. 51.

the owners. They are extensively used in Germany, Switzerland, France, and Austria, and for doing light work they are exceedingly satisfactory, and they are also relatively inexpensive, because there is no destruction of material in using them. There does not appear to be any good reason why they should not be widely

FIG. 53. A SCAFFOLD OF THE BRICKLAYERS' POLE TYPE, BUT WITH STOUT LADDERS FOR UPRIGHTS.

(From the new German Museum Building, Munich.)

adopted in the United States also, and we are of the opinion that they soon will be. They have been used in Germany for more than 25 years.

Fig. 53 shows a special form of ladder scaffold that is used in Germany for construction work. It is similar in its general design to the American bricklayers' pole scaffold. There is but one row of uprights, and each upright is a ladder of extra-heavy material. In the scaffold from which this photograph was taken there was no diagonal bracing. The working platform, which is at the very top in the engraving, was inclosed, however, by an effective fence composed in some places of three boards and in other places of four, in addition to the foot-board. It will be noticed that the supporting ladders lean toward the building, so as to afford greater security. The timbers of this scaffold were fastened together partly by cramp-irons and partly by rope lashings. A detailed view of a section of it, in which cramp-irons were used without any lashing, is given in Fig. 46.

VII. SPECIAL SAFETY FEATURES.

70. General Considerations. Thus far we have treated mainly of the strength and stability of the scaffold. In the present section we shall consider certain other features that relate to safety alone, and have little or no relation to the security of the structure itself. Prominent among these are guard-rails, foot-boards, wire-net screens along the sides of the working platforms, and special protective roofs, or coverings, over passageways and workplaces where men may be exposed to danger through the falling of materials from the scaffold above. Safeguards of this nature often receive scant attention in American practice; but they are of great practical value, and the systematic adoption of them would materially reduce the scaffold accidents that now occur.

The particular protective features that are mentioned above are simple and inexpensive, and they should be applied to every scaffold to which they can be adapted. (Compare paragraph 89.) Fig. 27 shows an ordinary bricklayers' pole scaffold with a hand-rail and foot-board applied to it, and in Fig. 29, which shows an independent scaffold in Leipzig, Germany, the hand-rails and foot-boards can also be seen.

The protective features that we have mentioned above are particularly important in connection with the suspended scaffolds that are now so widely employed by bricklayers, because these scaffolds are used

at great heights, so that a workman falling from one of them would surely be killed, and the fall of a small piece of material might produce serious consequences to a person below. The special features that are involved in applying hand-rails and foot-boards to suspended scaffolds are considered in paragraph 130.

71. Guard-rails. To protect the workmen from falling to the ground in case they should trip or stumble, a guard-rail or hand-rail should be provided along the outer edge of the working platform at a height of about 40 inches, measuring from the platform to the upper edge of the rail. A rail of this kind should be strong and substantial, and it should be made of selected, straight-grained material, free from knots. It should be securely nailed to the poles, preferably on the side facing the platform, because a falling man is safer when his weight tends to push the rail against the poles than he is when reliance must be placed solely upon the holding power of the nails. The rail may with advantage be 6 in. wide and 1 in. thick, though there is no need of insisting upon these exact dimensions. The main points are, to be sure that the rail is strongly secured to the poles in every case, and that it is able to resist, without the slightest uncertainty, the shock to which it would be subjected if a heavy man should fall against it forcibly. In some cases it is advisable to put up a second rail at about half the height of the first one, to give additional protection against the fall of workmen or of materials. Rope is sometimes tied from pole to pole, along the edge of a scaffold, to take the place of a more substantial railing. It is distinctly inferior, however, and it should be used only when a proper wooden rail is not available. In

erecting a bricklayers' pole scaffold, some builders nail the next ledger to the poles at the time the platform is laid, so that it can serve as a guard-rail. This is better than omitting the guard-rail altogether, but it is nevertheless far from satisfactory, because the ledger comes so high that there is plenty of room for a man to plunge down under it, if he should trip. It is always a mistake to rely upon a makeshift substitute like this. It is very little trouble to erect a special guard-rail that will be really effective, and this should be done in every case, at the proper time. A guard-rail should extend across the platform from the upright to the building, wherever there is a free end to the scaffold platform. This point is often neglected, even when the railing is well done at other parts of the scaffold. It is very important, however, because many men are killed or injured by falling from platforms at the end. Where the scaffold turns a corner, one of the guard-rails may be sprung so as to be nailed to the outer surface of the corner pole, while the other one is nailed to the inside of the pole.

Of the various woods that are available for the construction of guard-rails, spruce is doubtless the best.

72. Foot-boards. To prevent materials from falling over the edge of the platform and injuring workmen or other persons below, a foot-board (or "toe-board") should be erected along the outer margin of the scaffold platform, resting snugly against the outermost plank, so as to leave no space at this point. The foot-board should project above the platform by not less than 7 inches. It is important to have the foot-board fit against the platform as perfectly as possible, at all points, and care should be taken to see

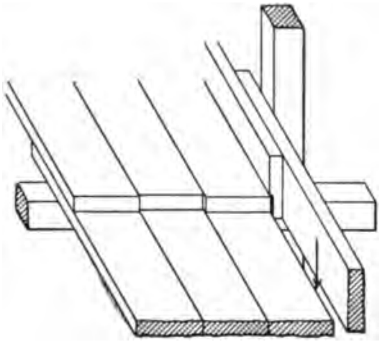

FIG. 54. ALL FOOT-BOARDS RESTING ON THE PUTLOGS.

(Tools or materials can fall through, as shown by the arrow.)

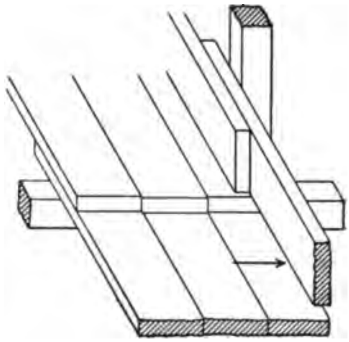

FIG. 55. ALL FOOT-BOARDS RESTING ON THE PLATFORM.

(Tools or materials can fall through, as shown by the arrow.)

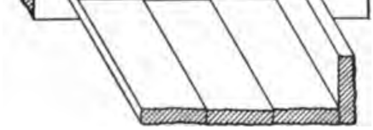

FIG. 56. FOOT-BOARDS RESTING ALTERNATELY ON THE PUTLOGS AND THE PLATFORM PLANKS.

(All joints are tight, and nothing can fall through.)

that it does so. If the boards or planks that constitute the foot-board rest upon edge on the putlogs or bearer-bars, and overlap each other as shown in Fig. 54, every other length of the foot-board planks will stand off slightly from the platform as indicated by the arrow. This particular difficulty may be removed by making the foot-board rest upon the planking instead of upon the putlogs, as shown in Fig. 55; but when this plan is adopted every alternate foot-board will stand *up* from the platform, leaving a space equal to the thickness of a plank, between the lower edge of the foot-board and the upper surface of the platform. These objectionable features may both be avoided by letting the foot-boards rest alternately upon the putlogs and upon the platform, as shown in Fig. 56. Tight joints are easily made in this way, and the only objection to the method is, that one foot-board will stand four inches higher (or lower) than the one next to it, if all are of the same width, and the platform planks are two inches thick. This is of no particular importance, provided the lower one stands at a safe height. Moreover, there is no good reason why the material used for the foot-boards should be of a uniform width; and if two widths are used,—one four inches greater than the other,—the foot-boards can be erected in accordance with the scheme shown in Fig. 56, and still be in line along their upper edges.

The foot-boards may be secured either to the planking or to the poles, but it is far better to secure them to the poles. They should also overlap each other at the poles, and never at points between the poles, where they are not supported. Where two foot-boards come together at a corner, one of them should project beyond

the corner, and the second board should abut against the first one. A block can then be set in the angle between the two, and both foot-boards can be nailed to it. A strong construction is secured in this way, and the joints between the foot-boards and the platform can also be kept tight.

73. Wire Netting. It is advisable to use wire netting along the side of a scaffold platform, wherever it is practicable to do so. When such netting is used it should be of stout wire, with a mesh not more than half an inch square, and it should extend from the guard-rail to the toe-board, or the platform, and be securely fastened at the top and bottom along its entire length. The wires should be soldered together at every intersection.

The use of wire netting is particularly important upon suspended scaffolds that are used for construction work, and this aspect of the subject receives special attention in paragraph 130. (See paragraph 134, also.) In connection with bricklayers' pole scaffolds the netting is less practicable. In the suspended scaffold it may be attached once for all, because the platform is shifted as a whole; but in the bricklayers' pole scaffold the netting has to be moved every little while, when the plank flooring is raised to the next level. It is no great task to shift the netting, however, and it is advisable to use it even upon the bricklayer's scaffold, for the sake of the increased safety that it affords. It should certainly be adopted whenever there is unusual danger of injury to persons on the ground below, from the fall of materials from the working platform. It is advisable to use wire netting on all the permanent platforms of independent pole scaffolds,—that is, on the

Fig. 57. Protective Platform over a Doorway.

platforms that are to remain fixed in position throughout the work. Stout netting should also be used along the free edges of sidewalk sheds and protective platforms, such as are described in paragraphs 148 and 149.

74. Auxiliary Platforms. When scaffolds are unusually high, or when the hazard to workmen and to the public, through the possible fall of materials, is unusually great, wide auxiliary platforms should be provided at suitable places, to catch anything that may fall from the scaffold. Platforms of this kind are of special importance in connection with suspended scaffolds, and further consideration of them is therefore reserved for paragraph 149.

75. Protection over Passageways and Workplaces. It is highly important to provide protection over doorways and passages that are used by workmen, when work is going on upon scaffolds or walls above them. Platforms for giving protection of this kind should be substantial enough to resist shocks due to the fall of fairly heavy masses of material. The planks should be nailed in place so that they cannot be easily displaced, and they should fit against each other tightly. They should also extend up to the wall, so that there will be no space between them and the wall for the fall of materials.

A protective platform of the kind here described is shown in Figs. 57 to 59. The doorway that is seen in Fig. 57 was used continually by the workmen, and teams were also driven through it into the building, from time to time, for the delivery of materials. The stringers, or thrust-outs, that are seen extending into the building in a nearly horizontal position in Fig. 58, supported the platform, and were securely nailed to

upright struts that were solidly wedged between the two floors of the building. The struts also had substantial cleats nailed to them, to assist in bearing any stress that might be thrown upon the platform. It will be observed that the platform was somewhat higher at the outer edge than it was where it came in contact with the building, so that rolling objects would tend to move toward the building, instead of escaping over the edge of the platform.

Fig. 59 shows this platform, as it appeared when viewed from the interior of the building after it had

FIG. 58. SUPPORT OF THE PLATFORM SHOWN IN FIG. 57.

been in use for a short time. The efficiency and value of the platform is quite evident, for it had become so completely covered with debris, which would otherwise have fallen to the ground directly in front of the doorway, that the planking itself could hardly be seen at

FIG. 59. ILLUSTRATING THE IMPORTANCE OF THE PROTECTIVE PLATFORM.

any point. It is also evident that a number of the objects that were caught by the platform were large enough and heavy enough to have injured the workmen severely.

Workplaces at which men are employed on the ground, and which are near scaffolds or walls upon which work is being done, should be provided with protection similar to that given by the platform shown above. A plank roof, erected over the workplace and supported by stout, well-braced supports, is usually the most convenient means of affording the desired protection. Far more attention should be given to shields of this kind, because under present conditions it is very common indeed to see men working at mortar beds and other places, close under a scaffold that is in active use, and without the slightest protection from the fall of objects from above. This is an unfortunate and altogether improper method of doing work, and many injuries result from it.

VIII. GENERAL FEATURES AND OPERATIONS.

76. Ladders. Ladders that are used in connection with scaffolds should be sound and in good condition. Their side-bars should preferably be made of spruce and their rungs of oak, hickory, or ash, and every part of the ladder should be straight-grained and free from defects. The rungs should be split and shaved to size, instead of being turned. The side-bars should be perfectly smooth, and free from slivers or projecting points. It is common to see ladders in use that have broken or badly-worn rungs, or rungs that have been repaired in some makeshift or unworkmanlike manner. This is a mistake, and many accidents have resulted from the use of ladders of that kind.

A ladder that is to be used for the transport of materials should not be more than 30 or 35 feet in length, and it should project above the landing to which it extends by at least five feet, so that a man who is about to step on or off the ladder may have support for his hands in doing so. If it becomes necessary to use a ladder that will not reach to such a height above the platform at its upper end, stout strips should be securely nailed to its side-bars, so that they may extend to the specified height; but recourse should not be had to such strips if a ladder of the proper length can be obtained.

In placing a ladder, it is advisable to have one of its rungs come flush with the platform to which the ladder leads. When this is not practicable, care should be

taken to have the rung that is nearest the platform stand two or three inches *above* it, rather than below it, because a better footing can be had in this way.

It is more or less common, in construction work, to extend a ladder by securing another one to it at its upper end, when the height to be surmounted is greater than can be spanned by a single ladder of convenient length. The ladders may be united in various ways. A very strong connection can be had by overlapping the two for a distance of five or six feet, and lashing them together with rope or wire cord. Considerable time is required to make a union of this kind, however, and a connection similar to that shown in Fig. 60 is therefore preferred by most American contractors. Ladders that are to be united in this way are made with their sides parallel, or nearly so, instead of tapering from the bottom toward the top. Their side-bars are also rectangular in shape, instead of being approximately semicircular. The upper ladder is narrower than the lower one, and fits inside of it, as shown. The two iron rungs by which the ladders are united should be about one inch in diameter, threaded at both ends, and fitted with nuts and with large, thick washers. In connecting the ladders they should be pushed together until the iron rungs rest solidly against the bottoms of the slots that are provided to receive them, and the nuts on the ends of the rungs should then be screwed up solidly.

It is exceedingly important to strengthen the side-bars of the ladders in some effective way, so that they will not split apart at the bottoms of the slots. This is usually effected, as shown, by putting a bolt through each side-bar, as close as practicable to the bottom of

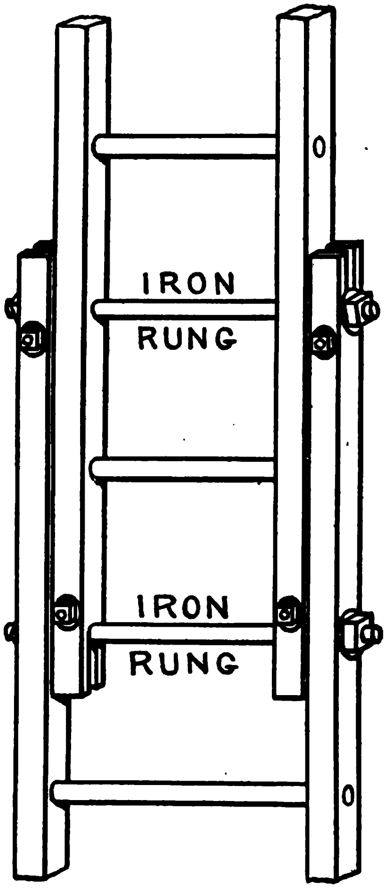

FIG. 60. AN APPROVED METHOD OF EXTENDING LADDERS.

the slot. As the safety of the construction depends largely upon the soundness of the wood at the slotted ends of the ladders, it is also highly important to protect the side-bars against decay, at these points, by coating them from time to time (particularly on the inside of the slots) with a waterproof preservative paint.

A ladder that is extended in this way, or by any other method, should be securely and effectively braced at the splice, and also at any other points that it may be necessary to support in order to prevent the junction from being subjected to a bending stress. There should be no stress whatever at the splice but a direct thrust, acting along the length of the ladder.

Ladders should never be extended unless the exigencies of the work require it. Whenever practicable it is far better to arrange them in single lengths, with a platform landing at the head of each ladder, somewhat as shown in Fig. 28. The ladders and their landings can be seen in this engraving, though not as clearly as could be desired, inside of the scaffold frame, in the panel in which the central man of the three that are shown is standing.

Fig. 32 shows a different disposition of the ladders. They are exterior to the framework of the scaffold in this case, leading to platforms that rest upon outriggers and are further supported by braces running from their outer edges to the framework of the scaffold. The lower ladder in this illustration is decidedly longer than we should recommend, but the general arrangement is well worth study.

In every case the foot of the ladder should be firmly secured, to prevent all possibility of slipping, and the upper end should also be fastened effectively, so that the ladder cannot slip sidewise nor be overthrown by being pushed bodily away from the platform against which it is supposed to rest. Ladders should be rigid, so that they will not spring to a sensible extent when in use. If they are not stiff enough in themselves to fulfil this condition, they should be supported at the middle

of their length by bracing extending to the framework of the scaffold or to some other fixed and solid object. In Fig. 32 it will be seen that the lower ladder is supported midway of its length by a thrust-out that is lashed to the scaffold itself.

Ladders up which materials are to be transported should be so arranged that they do not come one over another, and so that no one of them comes over a place where men are at work, or where they are likely to be frequently passing. If it is not possible to arrange the ladders in this way, each one of them should be sheathed underneath by tacking on boards in such a way that falling objects will be arrested by the sheathing, and be prevented from crashing down upon the workplaces or ladders below. Helpers carrying materials in hods or otherwise should be so handled that no two of them will be on a ladder at the same time. Serious accidents frequently occur from a violation of this precaution, and it is not at all uncommon, when two men are using the same ladder, for the upper one to fall, or let a portion of his burden fall, and thereby knock the lower man from the ladder. It is best to have at least two ladderways, one to be used exclusively by men going up, and the other exclusively by men going down. When this plan is in force it is easier to make the men go up one at a time; because when a single ladderway is used for travel in both directions, they naturally form the habit of ascending with their loads in gangs or groups of three, four, or five, in order to avoid confusion and delay through meeting others who wish to come down. (See also paragraph 87.)

77. Runways. Runways are exceedingly convenient for delivering materials to the working plat-

forms of scaffolds of all kinds, and as they can also be made quite safe, we recommend the use of them whenever they can be applied with advantage. They are particularly well adapted to low scaffolds, but when the space that is available about the base of the scaffold is restricted, or must be used for the storage of materials or for some other important purpose, it is sometimes difficult to install runways. If the runway is not too steep, the material can be carried up in barrows; and even when hods are used it is far easier and safer to walk up an inclined plank than to climb a ladder.

FIG. 61. RUNWAY SERVING AN INDEPENDENT POLE SCAFFOLD.

Runways should not be unnecessarily steep, and when, on account of lack of room or for any other reason, they must be made steeper than good judgment would indicate to be wise under other circumstances, they should be provided with cleats running crosswise and spaced not more than six or eight inches apart, to afford a secure footing for the men. In the winter the runways should be kept free from ice and snow, and if they become slippery at any time a liberal application of sand or ashes should be made to them.

Runways should be wide enough to avoid any chance of accident from a possible misstep. If they are high above the ground, or pass near deep holes, they should be guarded by stout hand-rails; and they should also be guarded by hand-rails if they pass over or near mortar beds, railroad tracks, high-tension electric wires, or other evident sources of danger.

In all cases runways should be rigidly supported or braced, so that they will not yield sensibly under the workmen as they pass. The planks should also be arranged or secured so that they cannot become displaced, either sidewise or endwise. The successive planks of the platform may abut against each other, so as to render the passageway as smooth as possible; but in this case every plank should be especially well secured, and great care should be taken to provide a wide and safe bearing for the ends where the successive planks abut. If the planks of the runway are allowed to lap over each other, then at the lap the plank that comes from below should lie over the one that comes from above; for if this arrangement is adopted, and a workman should trip against the overlapping end of the plank, he will trip when he is going

FIG. 62. TEMPORARY STAIRWAY USED IN CONNECTION WITH SCAFFOLDING.

down, and therefore when he is not carrying a load, and he will be better prepared to recover his balance and escape injury. This arrangement of the overlap is also far more convenient than the alternative one, when the material is transported in barrows.

78. Stairways. When a scaffold is to be used for a considerable time, it is best to build stairways for the use of the workmen. Fig. 62 shows a temporary stairway that was erected for the use of the workmen in connection with the construction of a building. This stairway was in the interior of the building, and gave access to the scaffolds from the inside. It will be seen that the inclination of the stairway was moderate and convenient, and that the height of the treads was likewise chosen with a view to making the ascent as easy as possible. A substantial hand-rail was provided on each side; and the whole was stiffened by supports, one of which is plainly seen on the right, connecting with the stairway itself and also with the railing, and resting against the floor of the building at its lower end.

An excellent arrangement of stairways, external to the building, is shown in Fig. 63, which is from a large model in the safety museum at Charlottenburg, Germany. As will be seen, there are four successive flights of stairs, and each one is provided with a double guard-rail, and braced at its middle point so as to be as rigid as possible. The landings are substantially constructed, and each one has a broad foot-board, and two guard-rails that are supported by braces running at an angle of 45° to the outriggers upon which the platform rests. The outriggers are also supported by diagonal braces that run to the framework of the scaffold. Each of these stairways is sheathed underneath.

79. Nails. For scaffold work, cut nails of large size and of the finest quality should always be used, and wire nails should never be employed. The nails that are used in scaffold work are often brittle, and

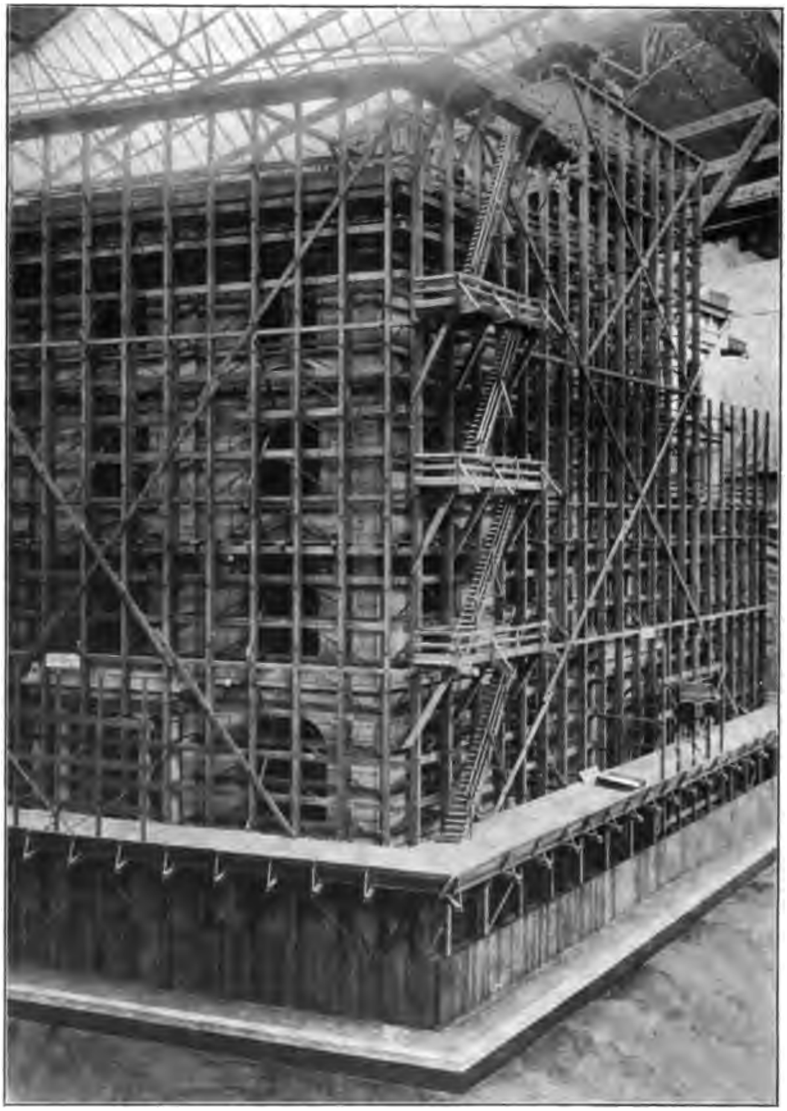

FIG. 63. SCAFFOLD STAIRWAYS WITH RAILED PLATFORM LANDINGS.
(From a large model.)

FIG. 64. SCAFFOLD NAILS, TESTED BY BENDING AROUND AN ARBOR.

therefore dangerous. Every lot of nails that is bought for this purpose should be thoroughly tested, and if the sample nails that are selected do not satisfactorily stand the test, the whole lot should be rejected, or used for some other purpose where strength is not a primary consideration.

Fig. 64 shows that nails of very fine quality can be had, if a little trouble is taken in selecting them. These nails were twisted, cold, around a cylindrical rod about 1/4 in. in diameter, and they stood the test without the slightest sign of fracture.

A rough but useful and easy method of testing nails in judging their suitability for scaffold work consists in driving them half-way into a block of wood, and then working them back and forth through a full right angle with the claw of a hammer,—bending them three times in each direction. If they stand this treatment without evidence of distress they may be considered to be satisfactory.

Builders of scaffolds sometimes leave the heads of the nails projecting somewhat, so that they can be more easily removed in taking the scaffold down. We consider this to be unwise, inasmuch as it weakens the structure to some extent, even when nails of extra length are employed. The nails should always be driven solidly home.

80. Dismantling Pole Scaffolds. The work of dismantling a pole scaffold should be intrusted only to experienced men, who understand this part of the operation and who have served as complete an apprenticeship as possible at it. The dismantling should be done in an orderly manner, beginning at the top of the scaffold and proceeding downward systematically. The braces should be left in position as long as possible, so that at every stage of the process the part of the scaffold that still remains standing may be secure. For a discussion of various other important points, see paragraph 159.

IX. BUILDING WITH HORSES.

81. Use of Horses. The masons' horse is widely used in the construction of buildings, both on the inside and on the outside of the wall. Its use externally is becoming less common than formerly, however.

When horses are used in laying a wall from the inside, the floors of the building should be put in as the wall goes up,—substantial temporary flooring being laid if it is not convenient to put in the permanent floors, at the time. The wall can be carried up to a height of about five feet from a floor without horses, and when this has been done horses are arranged along the wall and covered over with planks, so as to provide an elevated platform from which the wall is carried up by another five feet. If the height of the room in which the work is done calls for it, a second tier of horses is then erected upon the platform that was laid upon the first tier, a new platform is laid at the higher level, and the work proceeds as before. When the wall has reached the height of the next floor, the procedure varies to some extent according to the nature of the building. If it has a steel skeleton, and the floors are already laid, the bricklayers merely go up one story and repeat the operation already described. If there is no such skeleton, the building of the wall is suspended for a time, while another course of beams is put in place and a new floor is laid (either permanently or temporarily); after which the work proceeds as before.

The materials that are to be used in building the wall can be easily passed up by hand when only one tier of horses is in use. When there are two or more tiers, material may be delivered to the working level, by hand, in successive stages,—being passed first to the lowest platform, then to the one next above, and so on. It may also be carried up ladders in hods, in the usual way; and when it is practicable to use them, runways are recommended, consisting of inclined planks up which the material can be carried in hods or wheeled in barrows.

If the material is to be passed up in successive stages, as first described, it is well to have each platform at least three feet wider than the one immediately above it, in order that the helpers may have an opportunity to work freely and without danger of falling.

82. Design and Condition of Horses. All horses that are used for building purposes should be solid in construction, and of good design. They should be made of sound, selected material, and should be braced internally so as to be rigid enough, not only to carry their normal vertical load with safety, but also to resist deformation from sidewise thrusts.

Horses should not have their legs set at too wide an angle, because this makes them structurally weak and likely to spread under their loads. Nor, on the other hand, should they be too acute (or narrow) in the legs, because this lessens their stability. (As an example of a horse with legs set at too small an angle, see the one nearest the center of Fig. 67.) Experience has shown that the proportions indicated in Fig. 65 are about the best that can be had. The angle between the legs, here, is approximately 22 1/2°, and the dis-

tance from one leg to the other therefore increases by about 4 3/4 inches for each foot of vertical height.

Horses, the parts of which have become loosened or weakened in any way whatsoever, should not be used until they have been repaired in a thorough and workmanlike manner; and repairing should not be done to an excessive extent, because it is much better to discard a horse altogether, and replace it with a new and sound one, than it is to spend an unreasonable amount of time in patching up one that is old and weakened.

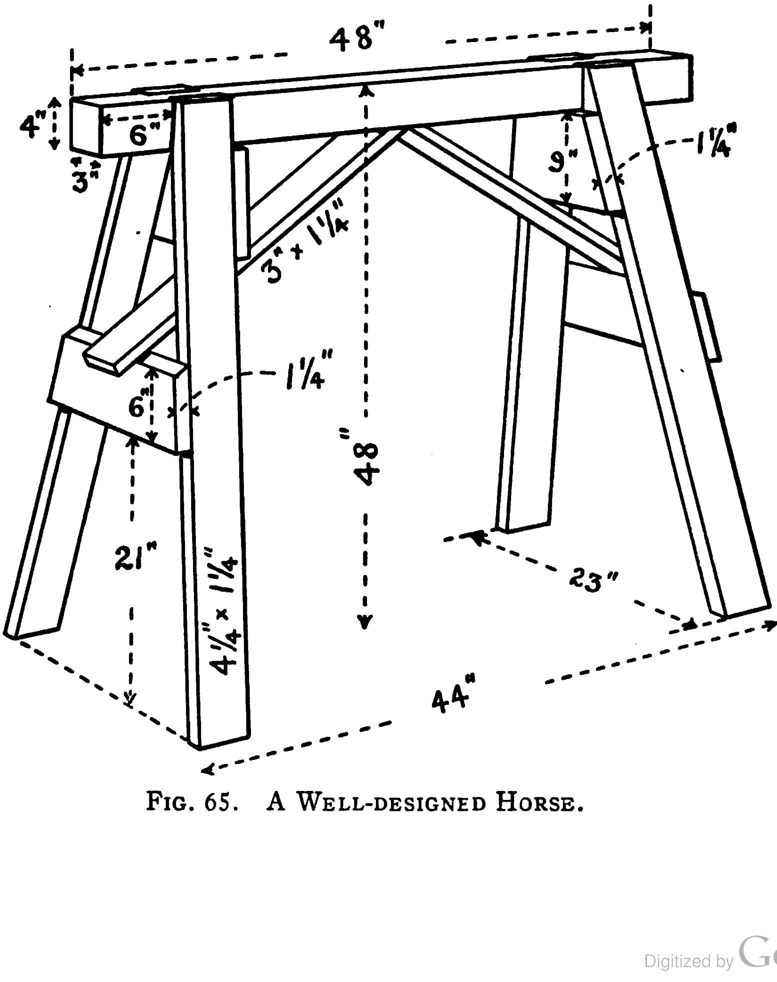

FIG. 65. A WELL-DESIGNED HORSE.

83. The Platforms on the Horses. The planking upon the horses should be carefully laid, and the planks should have their edges in close contact with each other, so that tools and materials cannot fall down between them. They should also be laid so that an accident from the tipping of a plank shall be impossible. The horses should be near enough together to support the planks properly, and to prevent them from springing at the middle. This condition ordinarily calls for at least three horses under every plank, one being placed at each end, and one or more in the middle. Care should also be taken to see that the planks actually bear against the middle horse or horses, so that they receive a real support there, effective enough to prevent all springing of the platform. In order to fulfil this condition, workmen commonly put pieces of brick or tile under the legs of some of the horses, to bring them up to the proper height. All four legs of the horse immediately over the doorway in the center of Fig. 66, for example, were resting upon bricks. Support of this kind should never be permitted, because the stability of the scaffold may be seriously imperiled by such makeshift arrangements. If a horse is not quite high enough to afford a proper support to the planking, it should be placed so that its legs rest directly and solidly upon the platform below, and a wooden strip of the proper thickness should be laid upon the top of the horse and securely nailed in position.

A horse scaffold is not adapted to the support of heavy loads, and it should never be used for the storage of considerable quantities of material. If the conditions are such that a heavier load than usual must be

carried, it is better to provide two horses between the ends of the planks instead of one; and in all cases the number and construction of the horses, and the design and construction of the whole scaffold, must be adapted to the load that is to be carried, taking account of the weight of the workmen as well as of that of the materials.

84. Use of Horses in Tiers. In making use of horses for erecting walls from the inside of a building it is seldom necessary to have more than two or three tiers of them. This will give a height at least as great as the height of an ordinary room, and when the wall has been put up one story the horses are shifted to the next floor above. When the work is done in this way, and the permanent floors are laid or the beams are properly covered with planks as the work proceeds, the danger of serious injury from falls is not great, if the horse scaffold is built with care. Many contractors, however, use horse scaffolds for outside work, building them up, sometimes, to a height of six or eight tiers. We strongly recommend some other form of scaffold in cases like this, because the horse scaffold is by nature less solid and stable than other types that can easily be had. If it is used in such cases, it should be constructed with great care.

In putting up successive tiers of horses, each horse should come directly and squarely above one in the next row below, because this insures the best possible distribution of stress in the planking, and it also tends to give the maximum degree of solidity and stability to the structure as a whole.

Some of the points that we desire to make will be better understood by reference to Fig. 66, which shows a horse scaffold that is erected in a way that does

not commend itself to the safety engineer, although work of this character is very common. It will be seen, for example, that although the principle of having the horses stand squarely over one another is roughly fulfilled on the right of the engraving, it is flagrantly violated on the left. Furthermore, it is poor construction to allow horses to rest upon the middle of a platform that is supported only at the ends, as seen in the central part of the engraving, where three tiers of horses are supported by the middle of the planking over the door. It is true that the supporting planks are double; but although this doubling is helpful, a construction like the one shown is weak, and the spring of the supporting planking makes all the platforms above it insecure.

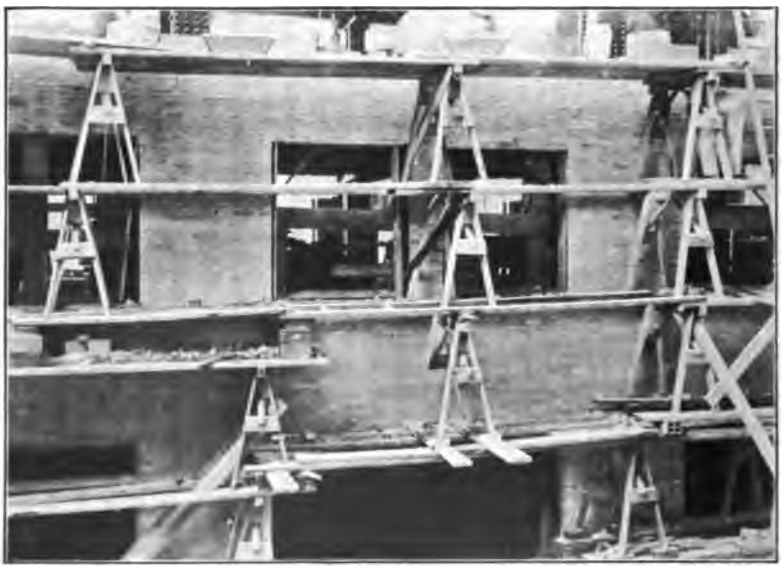

FIG. 66. AN IMPROPERLY-CONSTRUCTED HORSE SCAFFOLD.

Fig. 67 shows a method that workmen employ very commonly, for increasing the height of the working level by a couple of feet or so, when using horse scaffolds. Small supporting piers are built of brick or tile, or of other objects that may be handy, and on the top of these a few planks are laid. The little piers are sometimes fairly safe, but far oftener they are so insecure that it is hard to understand why the men are willing to trust to them.

If a small increase in elevation like this is desired, to facilitate the work, it is much better to provide a few well-made horses of half the usual height, and somewhat shorter than the ordinary horse. This not only promotes safety, but also saves money in the end, because a considerable amount of time is required to build and remove the piles of material that the men ordinarily use.

FIG. 67. A MAKESHIFT METHOD OF INCREASING THE HEIGHT OF THE WORKING PLATFORM.

(From a horse scaffold at Lausanne, Switzerland.)

85. Security of the Horses. This subject has already been considered in certain aspects in paragraphs 83 and 84, to which reference should therefore be made. In the present paragraph we take up a few additional points.

All that was said in the earlier paragraphs against the use of bricks and tiles under the legs of the horses, for the purpose of bringing their upper parts to the proper level, applies with special force to the lowest row of a tier of horses; because extra care should be taken to see that the horses have a firm and absolutely solid foundation to rest upon, in every case. The lowest tier of horses should not be allowed to stand in direct contact with the earth, but should be made to rest upon large sections of stout plank, that will prevent them from sinking into the ground. The legs are almost certain to sink in unequally if this precaution is not taken, so that there is a poor distribution of stresses in the scaffold, and in a bad case it may even topple over, bodily. The use of bricks or tiles for a foundation, in the place of the sections of plank recommended above, should not be permitted, because in many cases they are wholly inadequate.

Horses should never be allowed to rest merely upon beams or joists, nor should they be erected in any manner that would be likely to lead to a fall in case of a displacement such as might occur in the course of the work. Each tier of horses should preferably be entirely covered with planking, though it is an almost universal custom to use only two rows of planks on all the horses except those of the topmost tier,—one row at the front and one at the back, to support the legs of the horses next above. When horses are used on the inside of a

wall, a stout temporary flooring of planks should be laid to support them, as previously explained, if the permanent floor is not already laid when the wall reaches its level. If the floor is of concrete, or of tile and mortar, it should also be allowed to set thoroughly, before the weight of the horses is allowed to come upon it. The legs of the bottom horses of a scaffold should not be allowed to rest directly upon the tiles of floor arches, in any event.

On all scaffolds more than two tiers high the legs of the horses should be tacked down sufficiently to prevent any horse from shifting as the result of wind pressure, the thrust of ladders (see paragraph 87), the accumulated effect of repeated small motions, or other causes.

Fig. 68 shows a horse scaffold supported by thrust-outs projecting from the interior of the building upon which the scaffold was used. It will be seen that the horses of the second tier stand directly over those of the first tier in nearly every case. This feature of the construction is commendable, but we do not favor the use of horses in the way here shown, where a fall would probably be fatal. If horses must be supported upon thrust-outs in this way, they should be securely nailed to the planks upon which they rest, and the planks should also be nailed in place very firmly. The whole structure in fact, should be made as solid as possible. Guard-rails and foot-boards should also be provided, as described in paragraph 89.

When a tier of horses is to be erected upon one that is already in position, the planking over the lower tier should be carefully placed, and the horses of the next higher one should be set so that their legs will rest

solidly and completely upon the platform that is to support them. In the interest of increased safety, and to facilitate the delivery of materials, the lower platforms of horse scaffolds are sometimes made much wider than the higher ones. This construction is often advantageous; but when it is adopted the support of the exten-

Fig. 68. A Horse Scaffold Supported on Outriggers or Thrust-outs.

ded part of the lower and wider platforms is frequently neglected, totally inadequate provision being made for its stability. The extension platforms should receive the same care that is given to those that lie next to the wall.

Horses are sometimes set upon a narrow platform by turning them around somewhat so that they stand obliquely (or diagonally) to the wall. If a horse is turned to a sufficient angle, all four of its legs may be brought to bear upon a platform that is much narrower than the length of the horse. When this method of erection is followed, however, one or more of the legs of the horse are often left projecting partially or wholly over the edge of the supporting platform, so that a slight displacement would throw the scaffold down, with serious consequences to the workmen. Furthermore, when horses are arranged in this way the ends of some of the planks that they support often project to a considerable distance beyond some part of the oblique horses, so that there is danger of the platform tipping up when a load is placed upon it, or even when a man steps upon it. It is much better and safer to make all the platforms of proper width, so that the horses can stand upon them squarely and securely. The loss of time required to lay them in this way is far more than compensated by the increased security.

86. Shoring and Bracing Horse Scaffolds. When horses are set tier upon tier, the stability of the structure diminishes quite rapidly as the height increases. As a rule, the instability is already quite noticeable when there are three tiers, the upper platform being no longer solid under foot, but yielding to some extent, with a rocking motion, as the workmen move about. The

horses are sometimes carried to a much greater height than this, and as many as six or eight tiers of them may occasionally be seen, with a marked increase of instability. We do not recommend the use of horse scaffolds of so great a height; but if they are employed, every horse should be nailed to the planks that it supports, and to those upon which it rests. It is also highly important to brace the whole structure in some very substantial way. The best way to effect the bracing will vary with the conditions under which the scaffold is used, but in most cases it is best to run shores to the horses, and to give them additional support by means of window braces. (Compare paragraphs 48, 49, and 56.) A shore may be seen on the right of Fig. 66, running up to one of the horses, and some of the other horses are also secured by braces extending into the building through the window openings. These features are good, but the bracing of this scaffold is not as complete and effective as it should be.

87. Ladders on Horse Scaffolds. When ladders rest against horses or horse platforms, the same general precautions should be taken that are recommended in connection with ladders in other situations, and which are specified elsewhere. (See paragraph 76, in particular.) It should be remembered, furthermore, that a ladder that is supporting a load exerts an appreciable horizontal thrust upon the object against which it rests. Thus, a ladder inclined at an angle of 70 degrees with the ground (or 20 degrees with the vertical) may exert a horizontal thrust as great as 36 per cent. of the weight of the man and load upon it, in addition to whatever thrust there may be from the weight of the ladder itself. This means that when a

man weighing 160 pounds is carrying a load of 60 pounds up a ladder inclined as we have supposed, the horizontal push of the ladder against the object that sustains it at the top may be 80 pounds; and if the ladder rests against a horse scaffold, we may therefore expect the whole structure to fall down, if a horizontal push of 80 pounds, applied at the top, would suffice to overthrow it. This example is given for the purpose of illustrating the principle that is involved, and to call attention to the importance that the thrust of the ladder may have. As a rule, however, the ladders that are used in a case of this kind tend to push the scaffold against the wall, so that there is no danger of immediate overthrow. Repeated passing up and down the ladder may cause enough motion, however, to seriously disturb the structure in the course of time, and make it insecure. Where a ladder rests against a horse scaffold, it should come as close as practicable to a horse, and the plank against which it rests should be firmly nailed down. The horses that support this plank should also be nailed to the planks upon which they stand.

88. Runways. Runways are often efficient and convenient, for delivering materials to horse scaffolds of moderate height. A runway applied in this way is shown in Fig. 67. (For the general principles that should govern the design and construction of such runways, see paragraph 77.)

89. Guard-rails and Foot-boards. Guard-rails and foot-boards are seldom used upon horse scaffolds, because it is usually thought that scaffolds of this type do not lend themselves well to such treatment. These important protective features can be applied to horse scaffolds without any great trouble, however, and the

almost universal omission of them is due far more to our American indifference to safeguards, than to any real difficulty that is involved. In erecting a guard-rail on a horse scaffold, a piece of scantling, 2 inches by 4 inches, should be solidly secured to the side of the projecting end of the beam (or top piece) of the horse by three or four nails of generous size, as indicated at *A* in Fig. 69, to serve as an upright or post. The lower end of this post should rest against the end brace of the horse, at *B*, and be nailed to it. The guard-rail and foot-board can then be erected as shown. Guard-rails and foot-boards of this general nature should be provided on all horse scaffolds that are three tiers high or more, because it is a simple matter to install them, and

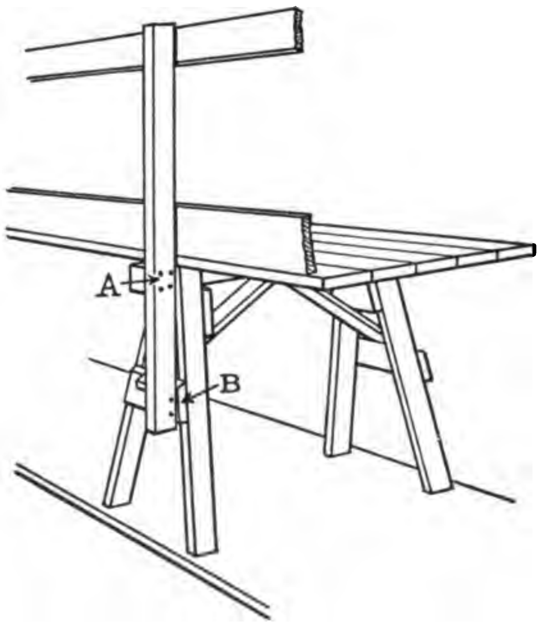

Fig. 69. Showing a Guard-rail and a Foot-board, on a Horse Scaffold.

they may prevent serious accidents. When another tier of horses is to be erected, the posts and rails should be removed from the horses to which they have been attached, and nailed to the new tier in like manner.

90. Protection of Workmen Below. Provision for the protection of persons who may be working or passing upon the ground nearly under a horse scaffold is important under all circumstances, but it is particularly so when foot-boards and guard-rails are not used. Careful attention should therefore be paid to the suggestions made in paragraph 75.

X. SUSPENDED SCAFFOLDS FOR CONSTRUCTION WORK.

91. Nature of the Suspended Scaffold. The suspended scaffold, as used in construction work and in making repairs and alterations about buildings, consists essentially of a platform that is hung from overhead supports by means of wire cables or steel straps, and which can be raised with more or less ease as the work proceeds, so that the bricklayers may always stand at a convenient height with respect to the part of the wall upon which the work is being done.

The suspended scaffold, as now employed by builders, was evolved from the familiar light swinging staging that is in common use among painters, by modifying the various parts so as to adapt them to the heavier loads that have to be supported, and to the greater number of workmen that must be accommodated in order to carry on the work of construction efficiently and rapidly.

92. Limited Applicability of the Suspended Scaffold. Since the suspended scaffold is supported from above, it can be used, in new work, only upon buildings that have steel or concrete skeletons, to which the overhead ends of its cables or straps can be attached.

It is seldom economical to use the suspended scaffold for buildings that are less than four or five stories in height. For lower ones it is usually cheaper to use the forms described in the third and fourth sections

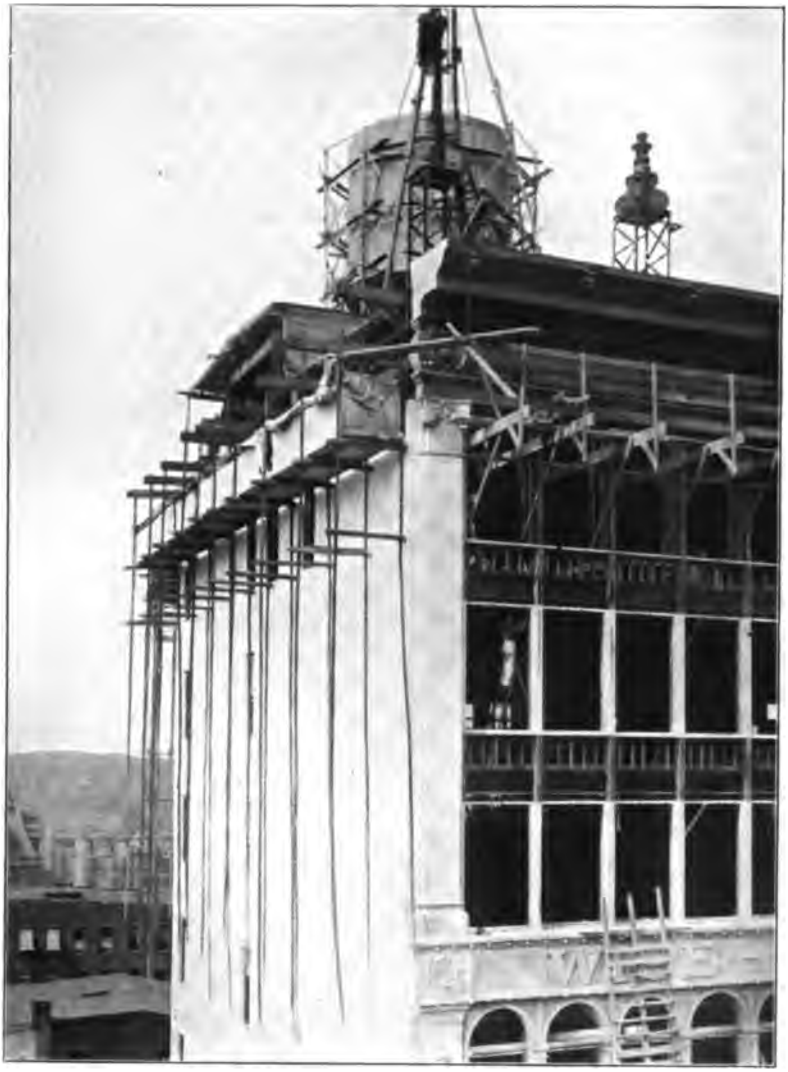

FIG. 70. THE CLARK SCAFFOLD.

(The platform is supported by perforated steel strips or ribbons.)

of this treatise (pages 38 and 83); but for the high modern buildings that are popularly known as "sky-scrapers" nothing can compete with the suspended scaffold, when it is correctly applied, either for economy or for safety to the workmen.

The suspended scaffold is most commonly employed for the laying of brick or terra cotta, though it may also be used for riveting and various other purposes. It is less frequently used in the construction of stone buildings, because in working with stone the blocks are ordinarily raised and swung into position by derricks or other forms of hoisting apparatus, and as these would interfere with the suspended platform and its cables, the stone is usually laid by the workmen from the inside of the building.

93. Advantages of Suspended Scaffolds. Several marked advantages are claimed for the suspended scaffold as a means of handling and laying brick upon lofty buildings with steel frames, and when the proper conditions are fulfilled there can be no doubt that these claims are justified.

The work of construction is facilitated, not only because the adjustment of the platform of the scaffold is capable of continuous variation so that the bricklayer can always work at a convenient height, but also because the system possesses great flexibility and adaptability. It is not necessary to delay the bricklaying until the skeleton is complete, and in fact it is the common practice to begin this part of the work when the framework has gone up to a height of about 100 feet, the bricklaying and the structural steel work thereafter going on together. Moreover, the laying of the brick can begin at any story, and this is a marked

advantage when the various levels of the building are to be faced with different materials, and the kind that is to be used for the lower stories is not at hand, while that required for the upper ones is ready to be set in place. The walls of the upper stories can be laid first, when using a suspended scaffold, and the lower ones can be filled in when the delayed material arrives. Examples of this are often seen in the erection of high buildings. (See Fig. 94, on page 241.)

The great flexibility of the suspended scaffold is another marked advantage. If the laying of the wall

FIG. 71. THE FOSTER SCAFFOLD.

(The putlogs are supported by steel cables, and are held in place by clips.)

must proceed unevenly for any reason, the platform can be raised where the work is proceeding most rapidly and can be kept at a lower elevation elsewhere. It is capable of continuous adjustment (at all events in those forms in which it is supported by cables running over drums), so that the men can always work at a convenient level. This tends to facilitate the whole operation, and it also helps the men to lay a wall having a neat appearance when done. For this last reason, suspended scaffolds are often used for the fronts or exposed sides of buildings, even when the other walls are put up by other methods.

Viewed from the standpoint of safety, the suspended scaffold leaves little to be desired when it is properly designed, constructed, inspected, and handled. A good steel cable under a reasonable direct tension is by nature much more trustworthy than a long wooden pole or column under compression. Moreover, the likelihood of damage to the scaffold from unforeseen extraneous causes is reduced to a minimum by suspending the platform from above, as was forcefully illustrated at the time of the fearful gas explosion in the yards of the Grand Central Station in New York City, on December 19, 1910. Twelve persons were killed by this explosion and 106 were injured. A suspended scaffold that was almost directly over the place where the explosion occurred was severely shaken by it, but the fifty workmen on the platform of the scaffold were merely thrown from their feet, and none of them received more than trifling injuries. If the scaffold had been of the pole type, it is exceedingly probable that many deaths would have resulted.

There is also less likelihood of injury to the men in the normal routine work about a suspended scaffold, because when it is properly installed and handled there is but little climbing about to be done in dangerous places, and but little exposure to hazards of any kind, save those that depend upon the strength of the scaffold itself, and upon the falling of tools and materials; and all these sources of danger can be minimized almost to the vanishing point by the exercise of reasonable precautions.

94. The Two Main Types of Suspended Scaffolds. In the evolution of the suspended scaffold, many different methods have been tried for supporting the platform and for varying its height with the progress of the work.

FIG. 72. ILLUSTRATING THE FLEXIBILITY OF THE SUSPENDED SCAFFOLD.

These have been repeatedly modified as the result of increasing experience and thought, until at the present time there may be said to be two standard types, to one or the other of which most of the modern approved scaffolds belong.

Wire cables are commonly considered to be superior to steel straps or chains as a means of suspension, and the use of cables is now so nearly universal that we shall give only passing attention to other methods of support.

In the forms that use steel cables for the suspension, the platform is usually raised by winding up the cables upon drums that are provided for the purpose, and the mechanism, consisting of the drums and their attachments and auxiliary appliances, by which each cable or pair of cables is wound up, is called a "scaffold machine", or simply a "machine".

The two main types of suspended scaffolds, to which we have referred, differ from each other mainly in the location of the machines by which the suspension cables are wound up, and in the means by which these machines are operated.

In one of them, which we shall call the "platform type", the drums and their attachments are secured to the platform itself, and move with it when it is raised. These "platform machines" wind up the suspension cables at their *lower ends*, and are operated from the platform by means of levers or cranks.

In the other form of machine, which we shall call the "overhead type", the drums and their attachments are located high overhead, at the points where the suspension ropes are secured to the steel framework of the building. These "overhead machines" wind

FIG. 73. THE "SALT LAKE" SCAFFOLD MACHINE.
(An early type, now superseded by safer forms. Note the light and poorly-designed pawl upon which the men must rely for safety, in the particular machine here shown.)

up the cables at their *upper ends*, and are operated from the platform by means of endless manila ropes that run over pulleys or sheaves connected with the drums, and hang down freely to the lowest level that the platform will occupy in the course of the work.

Although all scaffold machines that use wire-cable suspension can be classed as either "platform machines" or "overhead machines", according as the cables are wound up at their lower or upper ends, it is hardly necessary to say that the details of design and construction vary more or less among the various makers of such machines. It would be impracticable, in a volume of this size, to discuss, minutely, all the points of each make of machine. It appears to be wiser to give a full treatment of some one form of each of the two main types; and for this purpose we shall select the particular

machines to which, as "preferred devices of utility which best conserve human life and limb", a committee of the American Museum of Safety awarded the *Scientific American* gold medal in 1910. There is sufficient similarity among the different makes of cable-suspended scaffold machines, however, to insure a good understanding of the safe handling of all, when the special forms that we are about to discuss are once thoroughly comprehended.

95. Order of Treatment. We shall discuss the platform type of machine first, and then the overhead type. There are many considerations that apply equally to both, however, and to avoid unnecessary repetition we shall discuss these common features in a third section, after treating of the distinctive points that characterize each type of machine individually. Further counsel, of a general nature, will also be found in Section XIII.

PLATFORM TYPE OF SCAFFOLD MACHINE

96. Introductory. In the platform type of machine the drums upon which the suspension cables are wound up are located at the platform and are secured to it, as already stated. They are arranged in pairs, the respective drums of each pair being set opposite each other, one at the outer edge of the platform, and the other at the inner edge. Each drum works independently of all the others, so that the platform may be raised or lowered at any of its points of suspension, without being disturbed at any other place.

97. Description of the Machine. The drums of the machines here described are 3 1/2 inches in diameter

and 7 1/2 inches long, and are set with their axes crosswise of the platform (that is, at right angles to the wall that is being laid). At each end of each drum, and rigidly connected to it, there is a ratchet-wheel and pawl, the pawls being provided with stout springs to keep them always in position, whether they are pressing against the teeth of the wheels or entered into the spaces between these teeth.

One of the ratchet-wheels, with its pawl, serves simply to check the motion of the drum, and to prevent the cable from unwinding and the platform from falling, while the scaffold is in use and the machines are not being operated. The pawl of this wheel is secured to the main frame of the machine.

The pawl of the second ratchet-wheel is used for turning the drum and thereby raising the platform, and for this purpose it is mounted upon a short lever that swings about the axis of the drum as a center. To raise the platform of the scaffold the lever is pushed down by the workmen with the aid of an extension handle some 18 inches long, to give a greater purchase than the lever itself would directly afford. By each downward stroke of the operating lever the drum is caused to revolve by a few teeth, and the cable is wound up by a corresponding amount. When the lever is released, the pawl at the opposite end of the drum engages its ratchet and holds the drum stationary in its new position. The lever handle can then be raised freely, and by repeating this process a suitable number of times at each machine, the platform can be raised by any desired amount. An idle, grooved pulley or sheave, mounted upon a round horizontal rod that passes over the drum (and parallel to it) from one side

of the frame of the machine to the other, acts as a guide for the cable, and moves freely back and forth upon its rod or axle as the cable winds up on the drum.

FIG. 74. THE "PATENT" SCAFFOLD MACHINE—PLATFORM TYPE.
(This is the form of machine used at the *outer* edge of the platform. For the significance of the letters see paragraph 130.)

98. Effect of the Breakage of a Pawl or a Ratchet-wheel. By examining the construction of one of these machines it will be seen that if either of the pawls should break, the other one is quite competent to hold the drum and prevent it from revolving. The operating lever, by means of which the cable is wound up on the drum, is placed on that side of the ratchet-wheel which would move upward if the cable were to unwind.

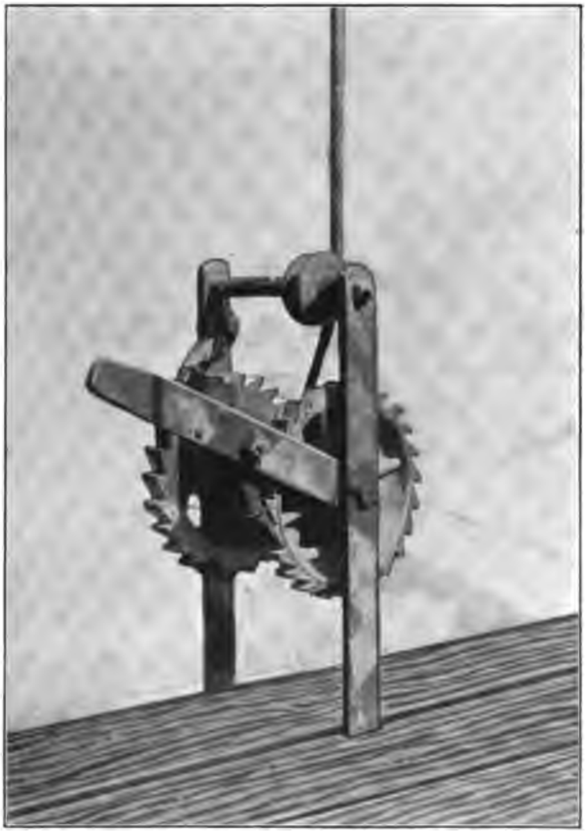

FIG. 75. THE "PATENT" SCAFFOLD MACHINE—PLATFORM TYPE.
(This form is used at the *inner* edge of the platform.)

Hence if the fixed pawl should break, the operating lever would fly against the horizontal cross-bar that carries the idle pulley at the top of the machine, and would thereafter serve to hold the machine and prevent further rotation.

99. Position of the Operating Lever while at Rest. The lever arm, after it has been used to elevate the scaffold, should be raised so as to stand in a nearly vertical position, and should be left near the cross-bar at the top. It is best to leave the operating lever as nearly upright as possible when it is not in use, as shown in the foreground of Fig. 76, not only because it is then out of the way, but also because if the fixed pawl should break, the one that is attached to the lever then becomes effective at once. If the lever arm were left horizontal, or at any considerable distance from the cross-bar or rod that would check its rotation in the event of breakage of the fixed pawl, it would be thrown violently against its stop by the weight of the platform, and the shock so experienced might fracture some part of the mechanism.

100. Possibility of Disengaging Both Pawls at Once. It might be thought that there is danger of the men getting both of the pawls out of mesh with their wheels at the same time, so as to allow the cable to unwind freely from the drum, and the platform to fall. This hazard is not a real one, however, for it is almost impossible to get both pawls out of mesh at once, and the thing certainly could not be done by accident, nor in any way except by taking very special pains to bring about this particular state of things. The shape of the teeth on the ratchet-wheel is such that neither pawl can be thrown out of mesh

FIG. 76. SCAFFOLD PLATFORM, WITH PLATFORM-TYPE MACHINES.
(There should be a foot-board and a side screen of wire netting along the outer margin of this platform. See paragraph 130.)

while it exerts any sensible pressure against its wheel. Before the fixed pawl can be thrown out, the drum must be backed away from it by pushing down the operating lever; and when the lever is thus depressed, the full load comes upon the movable pawl, which is thereby held firmly in place in the teeth of its wheel. In fact, the full load must always come upon one or the other of the two pawls, and so one or the other of them is always held in place, practically immovably. It would be hard to throw them both out at the same time, with any weight on the platform, even if a man were to undertake the task purposely and deliberately.

101. Thrust-outs, or Projecting Beams, for Sustaining the Scaffold. The cables by which the scaffold is suspended are attached, overhead, to horizontal beams called "thrust-outs" or "outriggers", which are secured to the steel framework of the building, and project outward over the scaffold. These thrust-outs are usually steel I-beams, not less than 6 inches in depth, and long enough to project at least a foot or two beyond the outer edge of the platform that is to hang from them, and also to extend into the building to a distance considerably greater than that by which they project out of it into the air. Each thrust-out should rest solidly upon one of the horizontal steel beams that are to form part of the outside wall of the completed structure, or, if it is necessary to raise the thrust-out somewhat in order to leave room for laying the floor arches, it should be securely blocked up so that its point of main support will come directly over this beam. The end of the thrust-out that lies within the building should also be securely fastened or anchored, to some other steel beam of the framework. If the

thrust-outs are of proper length the part that lies inside of the building will weigh much more than the part outside, and in this case the weight of the beam affords a considerable degree of security to the scaffold, so far as concerns the bodily overturning of the thrust-outs about their outer points of support. No reliance should be placed upon this element of safety, however, and the inner end of the beam should always be secured as solidly as it would have to be if the beam itself had no weight at all.

102. Anchor Bolts. The end of the thrust-out that is within the building is usually made fast by means of a special U-shaped anchor bolt that is threaded along each leg for a short distance and provided with stout, well-fitting nuts, and with a plentiful supply of thimbles consisting of short sections of pipe, just a little larger than the stock of which the U is composed. The inner end of the thrust-out being laid across the

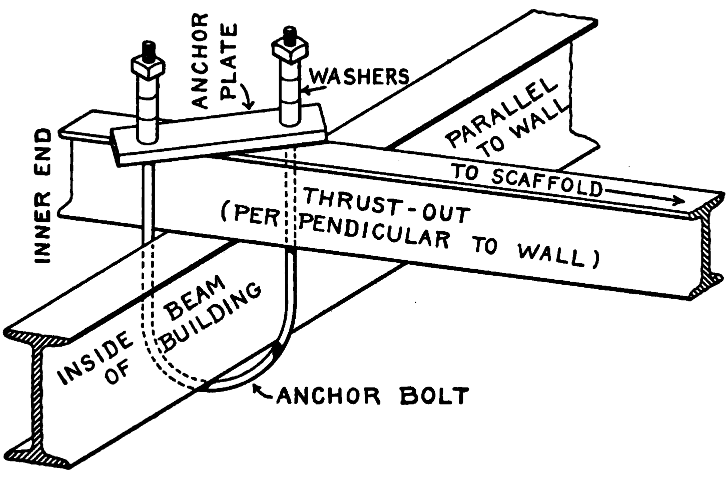

FIG. 77. SHOWING THE ANCHORING OF THE THRUST-OUT.

beam to which it is to be secured, the U-bolt is put in position in such a way that it surrounds both the thrust-out and the beam to which this is to be made fast. A yoke is next slipped over the ends of the U, the interval between this yoke and the threads near the ends of the U is filled up with thimbles, and, finally, the nuts are fitted to the threads on the U and screwed up tightly. Jam nuts are sometimes used on these bolts, but they are seldom necessary.

The depth of the fixed beams to which the thrust-outs are to be secured varies greatly, and therefore the legs of the U-bolts are made considerably longer than ordinary service would require. This construction is disadvantageous from certain points of view, because it is often necessary to interpose, between each nut and the yoke that it secures, a very considerable number of thimbles, through which the entire stress that comes upon the fastening must be transmitted. So far as simplicity is concerned, it would be better to thread the U-bolts over a considerable fraction of the length of each leg, so that whatever the heights of the beams to be joined might be, the nuts could be screwed down directly and solidly against the yokes themselves. But it would be hard to protect so great a length of thread, and prevent it from becoming jammed or otherwise damaged during transportation, or while the thrust-out is being set in place, or in consequence of some minor accident that may befall it while the building is being erected. If a thread should become thus bruised or jammed, the usefulness of the U would be impaired or destroyed; and it is mainly for this reason that the legs are threaded for only a few inches near their ends.

103. Use of Beam Clamps. It sometimes happens, on account of lack of space or for some other reason, that the standard U-bolt cannot be used in the way we have described, for fastening a thrust-out in place. In such cases it is customary to employ a clamp which grips the flanges of the thrust-out, or of the I-beam to which it is secured. In its common form, this clamp consists of two similar and equal pieces, which are shaped so as to fit snugly over the flanges of the beam on opposite sides of the web, and are held together by a stout bolt. A hole is drilled through the free

FIG. 78. A BEAM CLAMP.

(or projecting) extremity of the clamp, to receive a U-bolt or some other device, to which the load that comes upon the clamp is to be transferred.

In many cases where a clamp must be employed, it is sufficient to use it in connection with a U-bolt, as just suggested,—the clamp extending into some space or other that is too narrow to admit the U. Cases of this kind arise most frequently in making repairs or alterations upon buildings that are already standing. To attach the thrust-out to the steel skeleton of the building it is then often necessary to cut away some part of the brickwork or of the roof, and the use of the beam clamp makes it possible to obtain a satisfactory anchorage for the thrust-out with a minimum amount of damage to the building.

Where the conditions are such that entire reliance must be placed upon clamps at some point, because there is not enough space for a U-bolt to be used for any part of the connection, the thrust-out may be held by one clamp and the steel frame of the building by another, the two clamps being connected by some adequate and safe means that will naturally vary with the conditions. A safe and satisfactory connection may be formed by using a pair of stout steel straps, set parallel to each other and extending from one clamp to the other. The free end of each clamp is to be included *between* the steel straps, these being drilled at proper points, near their ends, so that a stout bolt can be passed through them and through the hole that is always provided in the clamp. Care should be taken, in drilling the straps, to have the bolt holes come in the proper places. Furthermore, the point of attachment to the framework of the building should be so chosen

that the stress on the straps will be sure to be a tension (or pull), and so that they can never be put in compression, under any circumstances.

104. Securing the Suspension Cables to the Thrust-outs. In this form of scaffold the suspension cables, at their upper ends, are secured to the thrust-outs by means of wrought-steel shackles. Each shackle is rectangular in general form, and is made by bending a strip of steel plate into such a shape that it will fit over the outrigger, or thrust-out. The free ends of the strip forming the shackle are brought near together, and project downward and parallel to each other, from the lower side of the thrust-out. They are drilled to receive a bolt, from which the suspension cable hangs.

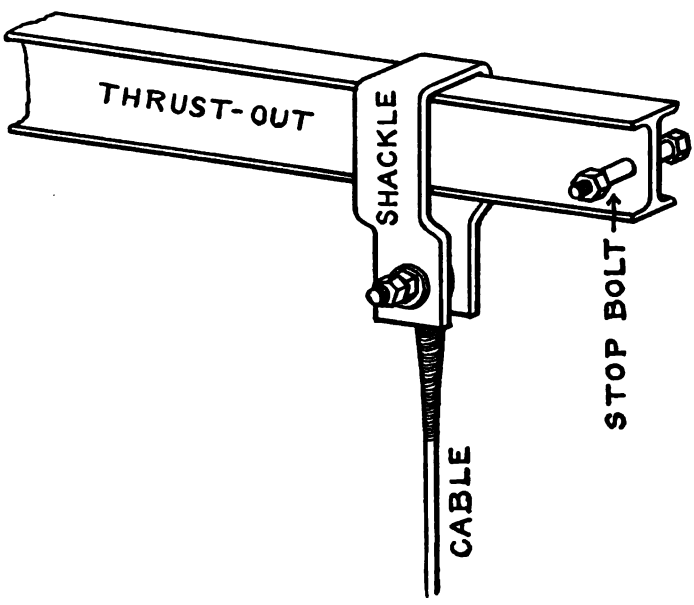

FIG. 79. ATTACHMENT OF THE CABLE TO THE THRUST-OUT.

The cable, at its upper end, terminates in a spliced loop, in which a steel eye is inserted. It is highly important that the splicing should be well done, and this part of the work should never be attempted by anyone but a man especially skilled in work of that nature. In practice, the splicing and the insertion of the steel eye are almost always done at the factory where the cable is made.

The eye of the cable is placed between the two downwardly-projecting ends of the shackle, and the bolt is slipped through the shackle and the eye, and fastened securely by a nut. It is essential that the nut should fit the bolt well and snugly, so that there shall be no possibility of its working loose from any cause, while the scaffold is in use. It is advisable to use a jam nut as an extra precaution in this respect.

The shackle to which the cable is secured is not usually fastened to the thrust-out in any way. The load being vertical and the thrust-out horizontal, and there being very little vibration in the cable or the thrust-out, there is no recognizable tendency for the shackle to slip either inward or outward. Moreover, on some buildings in which there are projections at various heights, it may be desirable to shift the shackles upon the thrust-outs from time to time, to permit the scaffold to hang properly while its platform is passing these projections. As a precaution against the accidental displacement of the shackle from some unforeseen cause, however, we strongly recommend that a hole be drilled horizontally through the web of the thrust-out, near its outer end, and that a bolt be set in this hole, long enough to prevent the passage of the shackle over the end of the thrust-out. The bolt

should be provided with a tightly-fitting nut, so that it cannot drop out, and it may be left lying loosely in its hole, although a better job may be had by fitting it, at each end, with a thimble made of a piece of pipe of such length that when the nut is screwed tightly home, the bolt projects about equally on both sides of the web.

105. Securing the Suspension Cables to the Machines. In most of the machines of the type here considered, the wire suspension cable is made fast to the machine by means of a joint made with melted babbitt; but in some few of them the end of the rope is merely passed through a hole of suitable size, located in some part of the drum or in some part of one of the wheels that are attached to the drum, and then secured by means of a clip of the Crosby type.

When the babbitted fastening is used, there is a boss cast upon a spoke of one of the ratchet-wheels, or upon the web that stretches between two consecutive spokes, and through it a hole is drilled, parallel to the axis of the machine, and at the same distance from the axis of the machine as the curved face of the drum upon which the cable is to be wound up. The hole in the boss is a little larger than the diameter of the cable, and it is recessed somewhat at the end away from the drum. The cable is "seized" or bound around with small wire a short distance from its free end, to prevent its strands from unwinding during the subsequent operations, and it is then thrust through the opening in the boss so that its extremity, after passing through the smallest part of the hole, projects into the recessed space. Finally, the individual wires at the end of the rope are separated and parted, and the whole is fixed solidly

in place with melted babbitt, as described in further detail in paragraph 125.

106. The Putlogs and Platform. In this form of scaffold the putlogs upon which the planks of the scaffold rest are each made of two angle-irons. These run at right angles to the face of the building, and they are bolted to the scaffold machines at the inner and outer edges of the platform. They are made long enough to support six nine-inch planks, this being the usual width of builders' planks in many cities.

The horizontal distance from one putlog to the next (or, which is the same thing, from one of the overhead thrust-outs to the next) is limited by various considerations, and it should never exceed 10 feet. It will often be less than 10 feet, in places, because it is not always possible to space the thrust-outs at uniform 10-foot intervals. A more detailed consideration of the platforms of swinging scaffolds is given in paragraph 126, where the features common to the two main types of such scaffolds are considered together.

107. Safeguard by the Pinching of the Platform Planks. As will be plain from an examination of the illustrations, the axis of the drum of the form of machine we are now considering runs crosswise of the platform, and the two upright sides of the frame that supports the drum, and between which it revolves, are far enough apart to admit one ordinary 9-inch platform plank between them. This is a feature well worth consideration, so far as safety is concerned, because it affords more or less protection against the fall of the platform, in case a cable should break or one of the machines should give way. By way of illustration, let us suppose that the machines are spaced 10 feet

apart, and that the platform planks are 14 feet in length, so that the two planks that meet at some one machine, and pass through the frame of that machine, overlap each other by a distance of four feet. If, now, one of the cables should break anywhere except at the extreme end of the platform, the corresponding machine would drop until the ends of the two planks that pass through it became pinched between the putlog and the lower teeth of the ratchet-wheels of the machine. If the platform is not too heavily loaded it might remain caught in this position until measures could be taken to restore it to its proper state. The scaffold has a considerable amount of strength in the position described, and although no reliance should be placed upon the platform being caught and held by the pinching of its planks in the machine, yet the design which makes this action possible certainly does afford an additional safeguard which is not to be wholly disregarded, since it might result in saving the lives of many men in event of the failure of a cable. It has been claimed that a scaffold not too heavily loaded will remain suspended by the pinching action of the planks, with three consecutive pairs of supporting ropes entirely cut away; but we have not seen the experiment tried. If one of the cables should break while the other one that runs to the same putlog remains sound and in position, the scaffold will drop on one side only; and even though it should not fall bodily, it would nevertheless be likely to tip over far enough to throw the workmen to the ground, if no proper means were provided to prevent them from plunging over the edge of the platform. If an inside rope should break, the men would probably be saved by the wall of the building;

and if an outside one should break, they might be saved by the guard-rail and netting which should always be provided along the outer edge of the platform. (Data respecting these rails and nettings are given in paragraph 130.)

108. Installing the Machines. In installing these machines the thrust-outs from which they are to be suspended are first set up, as described above, on the steel framework of the building. The height at which they are placed depends partly upon the height the finished building is to have, and partly upon the length of the cables on the machines. At the outset, the height of the thrust-outs does not ordinarily exceed 100 feet, because it is considered better, when the building is to be higher than this, to shift the thrust-outs during the progress of the work rather than to use cables of greater length on the machines.

The thrust-outs being in position, a line is passed down to the ground from each of them, and made fast to the end of the cable on one of the machines. The line from above is then drawn up, the cable on the drum of the machine being allowed to run off at the same time, and the eyelet end of the rope is thus raised to the thrust-out, where it is secured to its shackle by means of a bolt, as already described. The same process is repeated with each cable, until, finally, every one of the thrust-outs has two cables attached to it,—one to support the inner end of a putlog, and the other to support its outer end.

The machines are then placed in position, directly under their respective thrust-outs, and the planks are laid upon the putlogs. Finally, the guard-rails are put in place, and also the foot-boards, wire netting,

and any other devices that may be adopted for the safety of the workmen. (See paragraphs 130 to 135.)

In laying the platform planks, care should be taken to have all of the suspension cables as nearly vertical as possible. This is not particularly important while the scaffold is still at a great distance from the thrust-out, but any error in verticality that there may be at the beginning of the work becomes greatly increased as the platform is wound up toward the thrust-outs, and when the suspension cable becomes very short it may hang at a bad angle if care is not given to its proper adjustment at the outset.

The outriggers or thrust-outs should project from the building at least 18 inches or two feet beyond the outer ropes, so that in case of any slight shifting of the shackles, either by accident or by design, there will be no danger of their slipping off over the ends of the thrust-outs. This is important in all cases, and it is particularly so if the stop-bolt shown in Fig. 79 has not been provided.

109. Dismantling the Scaffold. In taking down a scaffold of this type the platform could be lowered to the ground, and the whole apparatus dismantled by reversing the process by which it was first erected. It is seldom done this way, however, unless the scaffold has been used for washing down the walls after they were completed, and the cables have thereby been unwound again. If no washing is done, the work will end with the cables wound up on the drums, and it will be easiest to dismantle the scaffold in its highest position. In that case the guard-rails, foot-boards, wire netting, and other safeguards are first taken off, and these and the planks of the platform

are passed into the building. The putlogs are then removed from the machines, and the drums are thereby left hanging, one from each of the thrust-out shackles. These are next taken in, the thrust-outs are disconnected from the steel framework, and the entire dismantled scaffold is sent down on the elevator that has been used for hoisting the building material.

110. Miscellaneous Safety Features. The handrails, foot-boards, and wire netting that are recommended for use in connection with the platforms of swinging scaffolds are considered in paragraph 130. Reference may also be made to paragraphs 71 to 73, which treat of the corresponding features of pole scaffolds.

OVERHEAD TYPE OF SCAFFOLD MACHINE

111. General Remarks. In this type of scaffold there is no mechanism at the level of the platform. The machines that wind up the supporting cables are mounted upon the thrust-outs from which the platform is suspended, and they are operated by means of endless ropes of hemp or other vegetable fiber, which pass over driving pulleys or sheaves at the machines, and hang down freely by the side of the platform, where they can be easily reached and manipulated by the workmen.

112. The Thrust-outs. The outrigger, or thrust-out, that is used in connection with the overhead type of machine consists of a pair of channel beams, which are set parallel to each other, and project outward from the face of the building in the same way as the single I-beam that has already been described in connection with the platform type. The channel beams should be 7 inches deep, and should weigh about 9 3/4

pounds to the foot. They are set with their flanges turned outward, and are held together at each end by a 3/4-inch bolt which passes through the central line (or neutral axis) of the web of each beam. Thimbles made of iron pipe are slipped over these bolts so as to keep the channel beams at a distance of 15 inches from each other, in the clear.

The channel beams that are used should be straight, and in good condition in all respects. The thrust-outs that they constitute are to be firmly secured to the steel framework of the building by U-bolts, yokes, and

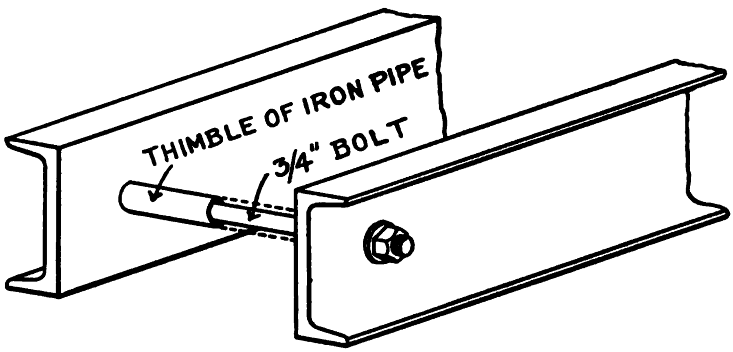

FIG. 80. SHOWING THE METHOD OF SPACING THE CHANNEL IRONS.

nuts, as already described in connection with the I-beam thrust-outs that are used with platform-type machines.

It sometimes happens that the thrust-outs of scaffold machines cannot be secured to the building by any of the methods that have been described, and in such cases it must be left to the ingenuity of the man who is erecting the scaffold to devise some method of securing them that will be both feasible and safe. One such method is shown in Fig. 81, where the thrust-out shown on the right-hand side of the engrav-

FIG. 81. SHOWING A SPECIAL METHOD FOR SECURING THE THRUST-OUT OF AN OVERHEAD MACHINE.

(One of the various artifices that may be adopted when the usual or typical method, by the use of U-shaped anchor bolts, cannot be used advantageously.)

ing could not be secured to the floor beams in the usual way, without weakening the floor arches by making holes through them. In this case the thrust-out was made fast by wedging it down with a pair of wooden uprights that were held solidly in position against the floor above by means of wedges that were nailed in place after driving. The uprights were also secured by cross-bracing, as shown in the illustration.

113. Description of Machines. The drums and other working parts of each machine are mounted upon a frame that is built up of angle-iron, bolted together. This frame fits into the space between the channel beams, and is not fastened to them, but is left free so that it can be slid back and forth to a limited extent as the exigencies of the building operations may require. There is no danger of the machine becoming so far displaced, outwardly, as to fall off from the projecting end of the thrust-out, because the cables that support

FIG. 82. AN OVERHEAD-TYPE MACHINE.

the platform of the scaffold pass down *inside* of the bolt that unites the channel beams of the thrust-out at their outer ends, and this would prevent more than a limited displacement of the machine.

Two suspension cables run up to each machine, one from the inside edge of the platform and the other from the outside edge, and a separate drum is provided for each of them. Each of the drums is secured to a toothed wheel in which a worm engages, and also with a ratchet-wheel which is not used in the regular operation of the machine, but which is provided with a pawl that can be dropped into place when desired. (The purpose of the pawl and ratchet is explained in paragraph 116.)

The worms that drive the two drums of the machine are mounted upon the same shaft, and are secured to it with pins, so that when the shaft revolves the drums are both caused to turn also, and the two suspension cables that run to the platform are wound up simultaneously. The driving shaft runs parallel to the thrust-outs by which the machine is supported, and at its outer end it carries a grooved pulley or sheave, over which, as already explained in paragraph 94, there hangs an endless rope (known as the "hand-rope"), by means of which the workmen operate the machine from the platform below.

The suspension cables are wound around the drums in such a way that they hang down, in every case, from the side of the drum that is furthest from the middle point of the machine, this arrangement having several advantages. It renders the machine much more compact than it would otherwise be, and it also has certain safety features that will be considered presently.

It is plain that the two drums of any given machine must revolve in opposite directions when winding up the suspension cables, and hence one of the driving worms (together with the gear that it engages) must be right-handed, and the other one left-handed.

114. Distribution of Stress in the Machine. The drums being located above the general framework of the machine, it will be seen that the vertical stress that comes upon the cast-iron standards that support these drums is compressive, and therefore not likely to lead to rupture.

From the fact that the winding drums revolve in opposite directions, it will also be seen that the endwise stress on the shaft that carries the worms is balanced, because one drum tends to pull this shaft in one direction, while the other one tends to pull it in the opposite direction.

One important point to which attention should be given in connection with machines of the overhead type, is the equalization of the load upon the two channel beams that together constitute the thrust-out. Either one of these beams should be strong enough to bear, alone, the entire load that comes on both of the cables; but it is much better to equalize the strain so that each of the channel beams will carry its own fair share. To accomplish this, care should be taken to start the cables so that whenever a complete layer has been wound up on one of the drums, a similar complete layer will have been wound up on the other one at the same time, and in such a way that when one of the dependent cables is near to one of the channel beams, the other dependent cable will also be near to the other channel beam at the same time. As the winding or unwinding proceeds, the

tendency will then be for the two tangent points, at which the cables leave their respective drums, to move back and forth symmetrically, so as to be always on opposite sides of the center line of the machine and always at equal distances from it. In this way the loads that are thrown on the two channel beams are equalized; and although the *bending moments*, generally speaking, will not be identically the same on both beams at any one given instant, yet the maximum values that these bending moments can have will be the same for both of them, if the ideal conditions that have been assumed to exist are actually realized. It is not possible for these conditions to be realized absolutely, and at times it may happen that they are not even roughly approximated; but careful attention should nevertheless be paid to arranging the cables as indicated, because when this is done the tendency toward equalization of the stress in the channel beams will, in most cases, be quite marked.

There is no stress on the hand-rope by which the machine is operated, save that which is due to its own weight and to the pull of the operators. In a properly designed machine, kept in good condition in all respects, a man can easily work the hand-rope with one hand, unless there is a heavy load on the platform.

115. Effect of the Failure of a Worm-pin, by Shearing or Otherwise. It will be noticed that since the cables are wound so that the free (or dependent) end of each leaves its drum on the side that is furthest from the other drum, the stress between the drums and the worms tends to force the worms apart. The worms are secured to their shaft by means of pins which are 5/16 in. in diameter or thereabouts, and which are

fitted with smaller split-pins at their ends. While reliance must be placed upon the worm-pins for holding the load under ordinary circumstances, it is to be observed that these pins are by no means essential to the safety of the platform. If one of them should shear off, the worms would simply be thrown against the end supports of their shaft. There is a space of only about one inch, at either end, between the worm and its support; and in the event of a pin-failure, each worm, when it had come to rest in contact with the support against which it would be thrown, would still be safely in mesh with its gear, and no fall of the scaffold could occur unless the supports of the worm-shaft should break, in addition to the shearing of the pin.

116. Riding of the Cables on the Drums. In the platform type of machine every cable is operated separately and individually, and for this reason the platform can be kept level at all times, if it is so desired. In the overhead type, however, the case is different. In operating the overhead machine by means of the endless hand-rope the two drums of each machine always revolve through the same amount or angle. If the suspension cables wind up in an ideal and perfect way, the platform, so far as tipping in a direction perpendicular to the face of the building is concerned, will always remain level, if it were level at the start. But it sometimes happens that the cables do not wind up as they should, and then the level of the platform may be seriously affected.

One of the cables, for example, may refuse to wind steadily across the whole length of the drum, but may begin to return before the end is reached, by "riding" back upon the layer that has been only partially com-

pleted. This is equivalent to making one of the drums larger than the other, and as the platform continues to be raised under these circumstances, one side of it is wound up faster than the other, so that it presently tips to an inconvenient degree. Moreover, when a cable "rides" in a certain way it may occasionally snap back again toward the correct position, and thereby subject the whole structure to a jar that it should never receive.

The "riding" can sometimes be remedied by merely reversing the hand-rope until the platform has been lowered to a point at which the cables are in proper condition on their drums. If the platform is

FIG. 83. ILLUSTRATING THE "RIDING" OF THE CABLES.
(Note the condition of the cable on the further drum.)

then raised again, it may go up in the right way, with the cables lying smoothly on both drums.

When this simple expedient does not suffice to correct the trouble, it is necessary to proceed in the following manner. A man first crawls out upon the thrust-out at the top of the building, and on the drum that has wound up the platform too far he throws the pawl so that it engages in its ratchet, and thereby prevents this drum from turning backward in the subsequent operations. The scaffold is then lowered a trifle, by reversing the endless hand-rope, until the pawl that has been thrown in is set up solidly against the next tooth of the ratchet. The pawl that has been thrown in will then be holding the entire load that comes upon its drum, and there will be no thrust between the corresponding worm and its driving wheel. The pin securing this worm to its shaft is then removed, so that the shaft can turn freely while the worm remains stationary. It is to be noted that the worm-pin can hardly be removed while the gear of the drum bears against the worm with the usual force that is exerted between the two under running conditions, because when there is any considerable thrust at this point the friction of the pin against its hole is very great.

The worm-pin having been removed from the worm that engages the drum that has wound up its cable too far, the next step is to pull on the hand-rope in the direction that corresponds, normally, to the raising of the platform. The drum carrying the cable that is too high will not be affected, because its worm is disconnected from the driving shaft; but the other drum will be made to revolve, and as a result the low side of the platform will be raised, while the high side remains

stationary. When the platform has been made level by this means, the worm that has been disconnected is again secured to the driving shaft by the insertion of its pin, and the pin itself is made safe by the insertion of the smaller split-pin. The whole platform is then raised sufficiently to permit the attendant to throw out the pawl that has held one of the drums stationary during this operation, and the scaffold is once more ready for use.

117. Precautions to be Observed in the Foregoing Operation. The operation described above, for adjusting a platform that has been thrown out of level by the riding of one of its cables, is at best a delicate one, and it must be performed with judgment, and only by skilled and careful men. It is best to have it performed by some representative of the company that owns the scaffold, rather than by a man in the employ of the contractor who is using it, because by so doing there is greater certainty of the work being done properly. The owners of these scaffolds are always ready to give assistance in this way, and in the leasing of the scaffold machines they often insist upon being allowed to make this adjustment, as one of the conditions of the rental; but when the scaffold is at such a distance from the nearest representative of the owners that the builders would be put to great inconvenience by the delay involved in sending for a specially-trained man, it becomes almost necessary to have the adjustment made by one of the employees of the contractor who is erecting the building. In this case we must once more emphasize the importance of having the adjustment intrusted only to intelligent men, who understand the machine thoroughly, and who are well aware of the paramount importance of doing the work carefully and properly.

In adjusting a machine the cables of which tend to ride improperly, it is common to *turn the disconnected worm toward the center of the machine* by hand, after the pawl is in place and the hand-rope has been backed until the strain between the worm and its wheel has disappeared. This procedure is often recommended even by those who are intimately familiar with this type of scaffold machine, and its object is to throw the worm entirely out of mesh with its wheel. Throwing the worm out in this manner is not at all necessary, and it is in fact to be strongly discountenanced because it introduces a new and totally unnecessary source of danger. The worm should be left in place after it has been disconnected from its driving shaft by the removal of the pin, because it does not interfere with making the adjustment, and if it remains in mesh with its wheel it may be the means of preventing a serious accident in the event of the failure of the pawl, or of the ratchet-wheel that the pawl engages.

It is of the greatest importance to see that the pawl actually enters its ratchet-wheel to the full depth of the tooth, when the platform is to be leveled; for if it rests only against the corner of a tooth, either because the tooth is filled with dirt or for any other reason, the pawl may spring out of mesh, or the end of the ratchet-tooth may break off under the strain. But if the worm is left in mesh with its wheel after the removal of the pin, then in case of the failure of either the pawl or the ratchet, the gear of the drum will simply cause the worm to slip along the shaft for a distance of an inch or two, until it brings up against the end support of the driving shaft, as explained in paragraph 115, and any further rotation of the drum will then be prevented.

Fig. 84 illustrates an accident that occurred in consequence of the improper handling of a scaffold machine by an unauthorized person who did not understand the correct way to manipulate it in leveling the platform. The photograph was taken immediately after the accident, and the machine is supposed to be in the exact condition in which the accident left it. The cable on the drum that is now empty had begun to ride improperly from the very outset, and the watchman on the job, noticing this, attempted to remedy the trouble and have the scaffold ready for the men when they came to work at eight o'clock in the morning. He first crawled out upon the outrigger and disconnected the worm that operated the drum that was at fault, working it back into the position where the photograph shows it, near the middle of the machine. He evidently did not throw the pawl securely into mesh with its ratchet-wheel. He next went below for some reason, and according to the best evidence available he jumped down upon the platform, from a small height, at a point immediately under the machine. As the pawl had not been properly meshed with its ratchet-wheel, the shock caused by the man's jump let the scaffold down, which would have been impossible if the worm had not been incorrectly disconnected from its gear. When the cable had unwound to its full length the end was no doubt pulled out of the socket to which it was attached, or broken off close to the socket. The man fell a considerable distance and was killed.

118. Insertion of the Worm-pin. Attention should be given to the fact that although the worm-pins on these machines will always fit when the worm is in

one position, they may not do so when the worm is turned half-way around. The worm is commonly made of cast iron, and the shaft to which it is secured is made of steel. In drilling the hole for the worm-pin the worm is set in place upon its shaft, and the drill is passed through both the worm and the shaft, in one operation. This insures a true, fair hole for the pin, so long as the worm has the same position on the shaft that it occupied when the hole was first drilled. In making the hole, however, it is hard to drill through the exact center line of the worm and the shaft; and more-

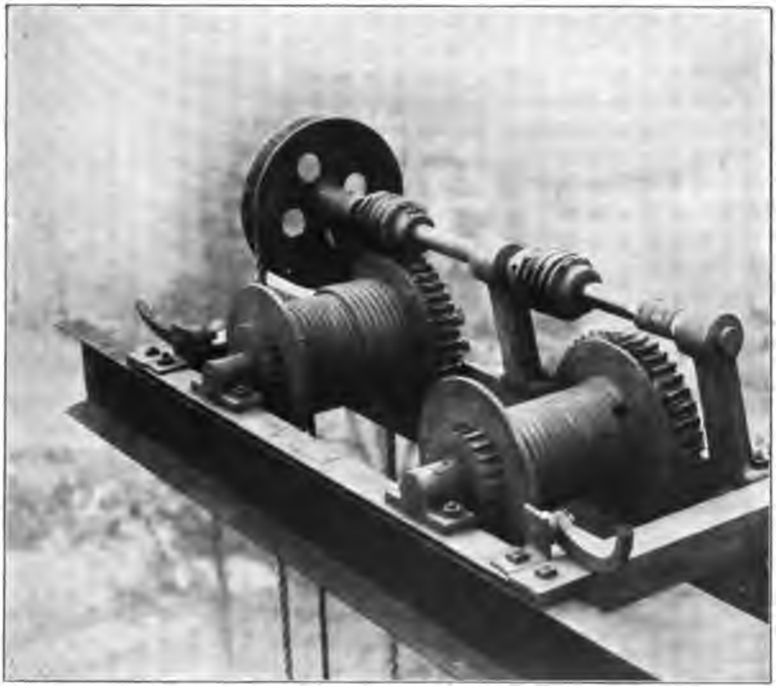

FIG. 84. ILLUSTRATING THE IMPROPER HANDLING OF AN OVERHEAD MACHINE.
(See paragraph 117.)

over, the drill, when it strikes the steel shaft after penetrating the first thickness of the worm, is likely to be deflected to a slight extent so that when the job is completed the pin will fit nicely with the worm in its original position, but will not pass through the hole, properly and freely, if the worm is revolved on the shaft through half a turn. This fact is often overlooked by those operating overhead scaffold machines, and the result is that worm-pins, after they have been removed for adjusting the drums in leveling the platform as described above, are sometimes hammered violently in an attempt to drive them through with the worm in the wrong position. The pins may be badly damaged by this rough treatment, and it doubtless happens, occasionally, that they are left only part way through, because it seems impossible to get them to go in properly. The remedy, in case of an apparent misfit of this kind, is very simple, and consists in merely bringing the holes fair by revolving the worm-shaft through half a turn, before trying to secure the loose worm in place with its pin. It would be well to mark each worm and its shaft with a prick punch or otherwise, so that there may be no uncertainty as to which way the worm should stand on the shaft, when it is ready to receive its pin.

119. Attachment of the Suspension Cables to the Drums. The drums upon which the ropes are wound are hollow, and the cables are usually secured to them as follows. Two holes are made, opposite each other, in the cylindrical surface of the drum, one (which fits the cable) being 1/2 inch in diameter and the other 1 1/2 inches or thereabouts. The cable is passed through the half-inch hole first, and is then carried

straight on through the drum, so that it comes out again through the 1 1/2-inch hole. The projecting end is next put through a kind of iron collar that is technically known as a "reducer", and is secured to it by pouring in melted babbitt metal as described in paragraph 125. When this has been done the cable is pulled back through the 1 1/2-inch hole until the iron collar, or reducer, to which its end has been secured rests against the inner side of the drum, at the half-inch hole.

120. The Putlogs and the Platform. In the overhead type of scaffold machine the platform planks are supported by putlogs, each of which consists of a pair of angle-irons bolted together, with thimbles between to keep them at a distance of about one inch. The lower ends of the suspension cables are fitted with eyes that are spliced into the rope, as described in paragraph 104 in connection with the *upper* ends of the cables in machines of the platform type. These eyes are placed between the angle-irons that form the putlogs, and the lower end of each suspension cable is secured by passing a bolt through the eye of the cable and through both of the putlog angle-irons.

The width of the platform, and the general character of the planking, are the same as already described in paragraph 106 in connection with the platform type of machine; and a more detailed consideration of the platforms of swinging scaffolds in general will be given in the next general division of this treatise, wherein the features common to the two main types of such scaffolds are considered together. (See paragraph 126.)

In the overhead type of machine there is no provision made, ordinarily, for the support of the planking in case of the breaking of a cable, as there is in the

particular form of platform machine we have described; but this feature can be secured in any suspended scaffold, if desired, by the means explained in paragraph 129, below.

121. Installing and Dismantling the Machines. In installing the overhead machine, the channel beams that constitute the thrust-out are first bolted together and are then set in position, overhanging the wall that is to be built. The thrust-out, thus made ready, is next secured to the steel framework of the building by means of U-bolts and yokes, as already described, after which the machine, with its cables properly wound up on their respective drums, is laid upon the thrust-out, and pushed outward from the building until it is directly over the place where the platform is to hang. Then the putlog is made fast to the cables, and when all the machines are thus made ready the planking is laid upon the putlogs, and the hand-ropes are installed, as well as the hand-rails, foot-boards, wire netting, and other safety auxiliaries.

When the scaffold is to be taken down again, the procedure followed depends to a large extent upon the height of the thrust-outs at the completion of the work. If they are more than one cable-length above the ground, it is usually easiest to dismantle the whole scaffold, planking and all, at the highest level, close to the thrust-outs. In this case the planks and all the other parts may be sent down on the elevator that was used for raising the building materials, or they may be lowered in any other convenient manner. On the other hand, if the thrust-outs are not more than one cable-length high when in their final position, it may be more convenient to lower the platform to

the ground and dismantle it there, removing even the putlogs, so as to leave nothing hanging from the thrust-outs but the suspension cables themselves. These are then wound up on their respective drums, after which the machines and their thrust-outs are lowered on the elevators or otherwise.

To facilitate the winding up and unwinding of the suspension cables, the shafts or axles of the drums on the type of machine here under consideration are provided with square ends, over which a handle or "key" can be fitted. When the cables are to be raised or lowered, *before any load has been attached to them*, or *after every load has been removed*, the pawls of the respective drums are first thrown into mesh with their ratchet-wheels, the worm-pins are then removed and the worms turned toward the middle of the machine by hand until they are free from their gears, and the drums, thus set free, are then operated by the handle to which reference has already been made. This is much quicker and easier than turning the hand-rope sheave with the machine in full gear, but it should never be attempted when there is any load whatsoever hanging from the cables.

Workmen often manipulate the cables by turning the disconnected drums by grasping them by their flanges, instead of by using the proper handles. This practice should not be permitted.

122. Miscellaneous Safety Features. The hand-rails, foot-boards, and wire netting that are advised in connection with the platforms of swinging scaffolds are considered in the next general division of this work. Reference may also be made, regarding these points, to Section VII, page 130, which treats of pole scaffolds.

FEATURES COMMON TO BOTH TYPES OF SUSPENDED SCAFFOLDS

123. Varied Practice in the United States. Practice in the use of suspended scaffolds varies somewhat in different parts of the country, but the main principles are the same everywhere, and the differences relate mostly to matters of detail. In Chicago, for example, the standard platform plank is 10 inches wide, instead of 9 inches as in New York. In Chicago, too, it is usual to employ heavy wooden beams for the thrust-outs, in place of the steel I-beams or channel beams that are used in practically all other places. Other differences of this same minor character will be met with also, when comparing one city or region with another, but it is not necessary to dwell upon them further.

124. The Suspension Cables. The cables that are used for supporting the platforms of suspended scaffolds for building operations should be made of steel wire. They should be not less than half an inch in diameter, and should have an ultimate tensile strength of not less than five tons. The builders of scaffold machines mainly recommend and use galvanized cables, because these resist the action of the weather better than the plain ungalvanized ones. Galvanized cast-steel running rope, out of ordinary stock, should not be used, however, because in the absence of special orders to the contrary galvanizing is done mainly on cables that are not adapted for running over sheaves or drums. The cables for use on scaffolds should be made of what is known as "standard hoisting rope", and the galvanizing should be done to order.

It is essential, of course, that the cables should

possess not only strength, but also a considerable degree of flexibility, in order that they may not be damaged from being wound upon the drums. The likelihood of injury from bending is not nearly so great in scaffold machines, however, as it is in elevators and other forms of hoisting apparatus where the rope is being almost continually wound up and unwound.

Some form of protection against the action of the weather should be provided for the suspension cables. If they are galvanized, the coating furnishes sufficient protection so long as it is in good condition. When the cables are not galvanized, or when the galvanizing has become worn off in places, they should be treated with some approved preservative preparation. The rope makers furnish special substances for this purpose, but if these cannot be procured readily, good results may be had by soaking the cables with first-class cylinder oil or linseed oil, mixed with finely-divided graphite.

The cables should be thoroughly inspected, from time to time, to see that they remain in good condition; and if there is any question whatsoever about their absolute safety, they should be replaced at once.

125. Securing the Ends of the Cables with Fusible Metals. In fastening the end of a steel cable into a recess or socket by running in melted metal, a so-called "seizing strand", composed of fine wire, is first wound tightly around the cable, at a point that will lie just outside of the recess or socket when the job is complete. This is to hold the strands of the cable together, and prevent them from fraying during the subsequent operations. The cable is then passed entirely through the recess into which it is to be secured, so as to project

beyond it to a convenient distance, and its end, beyond the seizing strand, is next opened out so that each wire is separated from its neighbors until the whole has the appearance of a sort of brush with divergent bristles. The hemp center of the cable should then be removed as far back as the seizing strand, or as near to it as practicable.

Opinions differ as to the best procedure after this point has been reached. Many users of wire cables believe that each separate wire should be turned back upon itself so as to form a sort of hook, the point of which should lie, in every case, toward the center of the cable. In making the connection in this way, the hook-shaped ends of the wires are all drawn back into the socket or recess to which the cable is to be secured, and a tapered pin is driven lightly into the middle of the brush, to spread its separated and incurved wires. Melted lead or some other readily fusible metal is then poured into the recess so as to fill it completely, the pouring being so managed that the molten metal will run in among the separated wires as perfectly as possible. If the operation here described is well done, a fastening is obtained that should be stronger than the body of the cable itself.

Lead has been mentioned in the preceding paragraph as a material for filling in the sockets or recesses to which the ends of cables are attached, because it has been employed for this purpose quite extensively in the past and is still used to quite an extent at the present time. In fact, cable connections that are made with melted metal in this way are commonly known as "leaded ends", even when they contain no lead. The manufacturers of wire cables do not favor the use of

lead for making the ends, nor do they recommend bending the tips of the separated wires into hooks. Having frayed out the end of the cable as described above, and spread the separated wires out into a brush-like shape, they clean the wires thoroughly with gasolene and then fill the recess with melted *zinc*.

Zinc, as a filling material, has several marked advantages over lead, when it is properly applied. If the wires are perfectly clean, the zinc, when poured, will adhere to them firmly, as is illustrated in the ordinary process of galvanizing. Zinc also expands upon solidifying, and hence it tends to fill the spaces about the wires and within the recess, very solidly. Lead, on the other hand, will not adhere to the wires, but merely runs around them, so as to inclose them without adhesion. It also contracts upon solidifying, and therefore tends to loosen in the recess and around the wires. Moreover, it is not so strong or rigid as zinc. Lead is easier to handle than zinc, however, because it melts at a lower temperature, and (unlike zinc) it does not take fire when melted, nor does it volatilize to any important degree.

Builders of scaffold machines use babbitt metal quite extensively in making so-called "leaded ends" for the suspension cables. If the babbitt metal is of good quality it is greatly preferable to lead, because it is more rigid and it penetrates better among the wires. Care should be taken to use babbitt of first-class quality, however. This metal is often procured, for use in securing the ends of cables, from dealers in second-hand machinery and scrap metal. We consider that this is not a wise procedure, because there is great variation in the metal that is obtained in this way, and from time

to time the purchaser is likely to obtain a markedly inferior quality that should not be used for securing the cables. The total cost of new metal for this purpose is small, and it is much better to use an alloy that is prepared especially for the purpose, and mixed in known proportions.

When making a zinc end, the wires of the cable are sometimes pickled in acid in addition to being cleaned with gasolene, in order to insure as perfect a union as possible between the two metals. This is not to be recommended for general practice, however, because there is likelihood of free acid being left between the wires of the cable, just back of the zinc plug. Corrosion arising in this way is likely to continue when the cable is in service, long after the acid that started the action has become exhausted. If acid is used, the finished end should be immersed for a time in a solution of washing soda or soda ash, as soon as it has become cool. It is safer to rely on gasolene alone, for the cleaning, and to omit the acid altogether.

After a cable-end has been secured by the use of either lead, babbitt, or zinc, it is of prime importance to let the fused metal cool slowly, by natural radiation. It is a more or less common practice to throw the heated end of the cable, with its attached socket, into a pail of water, or to dash water over the hot connections as a whole, if the end has been made fast to a recess in some large piece of metal. This should be strongly discountenanced, because the sudden chill alters the physical character of the heated parts, affecting the cable particularly, and making it likely to fracture at or near the point where it enters the recess into which it is secured.

As the heat to which the end of the cable is subjected in making a so-called "leaded end" destroys any oil or grease that may have been on the surface or between the strands of the immediately adjoining part of the cable, it is well to soak the end in oil for a short time, or to treat it with some special form of dressing, before it is put into service.

126. The Platform. The planks composing the platform should be laid tightly together, so that there is no chance for even a small implement to fall down between them.

FIG. 85. HOOK FOR HOLDING THE SCAFFOLD NEAR THE WALL. (This is caught over a floor beam, and its left-hand end is wired to the suspension cable.)

The platform should hang close to the building, so that there will not be room for a man to fall between it and the wall. It is usual to arrange the scaffold so that there will be a space of two to four inches between the inner edge of the platform and the wall of the building, and hooks are often used to prevent the platform from swinging away from the wall,—these being caught over conveniently situated I-beams at one end, and wired to the suspension cables, near the level of the platform, at the other end. To prevent the platform

from swinging in too close to the building, fenders are also provided, consisting of pieces of plank running crosswise of the platform, tacked to it with nails, and projecting inward toward the building to a distance sufficient to insure the proper interval between the platform and the wall. In painters' scaffolds the ends of the corresponding fenders are usually fitted with small wooden wheels, which roll along the wall as the scaffold is raised; but the wheels are omitted from the builders' scaffold, because the platform, in this case, is supposed to be so adjusted that it will hang freely at the proper distance from the wall, and the fenders are provided merely to steady it.

The platform planks should be made of spruce when this wood is available, though first-class long-leaf southern pine is also acceptable for the purpose. Whichever wood is used, the planks should be of the quality indicated in paragraph 42, in connection with the bricklayers' pole scaffold. They are usually nine inches wide, and they should be at least two inches thick for all ordinary work, and correspondingly thicker than this if the work is unusually heavy. The planks are ordinarily twelve or fourteen feet in length, so that with the usual spacing of the putlogs each plank will overlap each putlog by either one foot or two feet. The platform should be laid with special care, and the planks should overlap the putlogs by the same amount at each end.

The putlogs upon which the platform planks rest should never be set further apart than 10 feet. Some builders separate them by an interval as great as 15 feet when planks of sufficient length can be had for the platform,—extra thick planks being used, if necessary,

to obtain the requisite stiffness; but the more conservative and cautious builders are agreed that this is a mistake, and that the ten-foot limit for the distance between the putlogs is wisely chosen, and should not be exceeded.

127. Passing Materials to the Platform. The materials that are used in laying a wall from a swinging scaffold are carried up inside of the building by a temporary elevator or by some other form of hoisting device, and are left at the floor nearest to the platform of the scaffold. When the platform is immediately opposite to a floor, it is easy to pass the materials out to it, either through a window opening or over the upper edge of the growing wall; but as the scaffold is drawn up with the progress of the work, it will presently reach a height at which it is no longer easy to transfer the material directly to the platform of the scaffold, from the floor below. It is customary to meet this condition by making use of auxiliary platforms supported upon horses inside of the building, these horse platforms being commonly used not only for passing materials to the swinging scaffold, but also for laying the inner courses of the wall at the same time. The use of horse platforms for the laying of brick is discussed elsewhere in this treatise, and in the present place they are considered merely as a means for delivering supplies to the outside scaffold.

A single inside platform, one horse high, suffices for the handling of the supplies until the swinging platform has risen seven or eight feet above the floor from which the delivery is made, but in erecting buildings whose stories are unusually high it may be necessary to use a two-stage inner platform, one level

of which is one horse high, while the other is two horses high; and three such platforms, at three different heights, may be required in extreme cases. The materials may be passed from one helper to another, from the floor where they are delivered by the elevator up to the highest of the horse platforms and then out upon the swinging scaffold; or runways may be provided, up which the materials can be transported to the desired level, by means of barrows or hods.

When the wall of a building approaches the floor above that from which the material has been recently delivered, it is common to send further supplies to the higher floor, before the platform of the scaffold has quite reached that level. They are then passed down to the working platform, instead of being raised from below. When this is done, special care should be taken to deposit the materials upon the scaffold platform gently, and without any sensible shock. In scaffold work generally, the helpers often throw loads down upon the platform from their shoulders, thereby jarring the whole structure and sometimes damaging it seriously. In all cases it is highly important to take whatever measures may be necessary, to prevent this dangerous practice from being followed. The general principle should always be borne in mind, that a load falling through even a short distance strains the scaffold to a far greater extent than the same load would, if it were deposited upon the platform gently.

128. Overloading the Platform. The platform of a scaffold should never be used for the storage of considerable quantities of material. It is necessary to have a certain amount on the platform in addition to that which the workmen may need at the moment,

in order to avoid the delays that would otherwise arise if the material were not supplied with perfect regularity. It should never be allowed to accumulate sufficiently to subject the scaffold to a serious strain, however. This fundamental principle must be borne in mind with special care, because the helpers often go right on delivering materials, even when the laying of brick has been suspended for a time. The whole operation should be subjected to a supervision effective enough to prevent the supply of materials from more than keeping pace with the quantities that are used.

129. Safeguard by the Pinching of the Platform Planks. This method of safeguarding is of secondary importance, but it nevertheless merits passing notice.

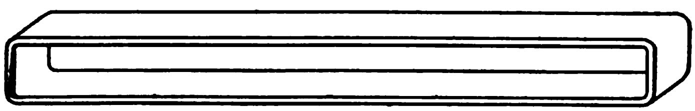

FIG. 86. STEEL STRAP FOR INCLOSING THE PLATFORM PLANKS.

It consists in providing a device of some kind, which, in case one or more of the suspension cables should break, becomes operative in such a way as to prevent the fall of the platform planks that the broken cable was designed to support.

In the form of platform scaffold described in Section X, the framework of the machine, as explained in paragraph 107, is supposed to be designed so that it will cause certain of the planks to bind together at their ends when they have dropped a short distance, and thus prevent a further descent. The same principle can be put into practice, in any other form of builders' suspended scaffold, by slipping over the ends of both courses of planks, where the two overlap,

a flat loop or closed strap of steel plate, of the general form indicated in Fig. 86. Such a loop is easily made by any good blacksmith. It should be about 3/8 inch thick and 3 inches wide, and long enough to take in six 9-inch planks easily. Its two long sides should

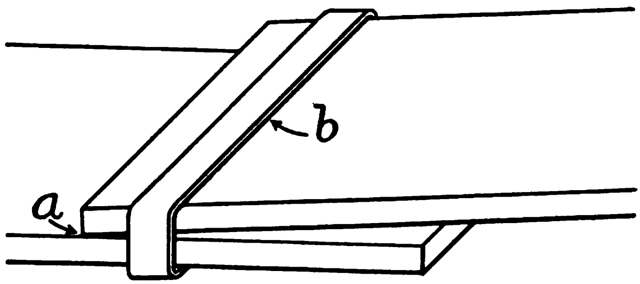

FIG. 87. WRONG POSITION OF THE STEEL STRAP.
(The strap is here too near the end of the upper course of planking.)

be separated by a clear space of (say) 4 1/4 inches, so that it may be passed readily over a pair of overlapping 2-inch planks. The weld in the strap should be carefully made, and should be located somewhere near the middle of one of the long sides.

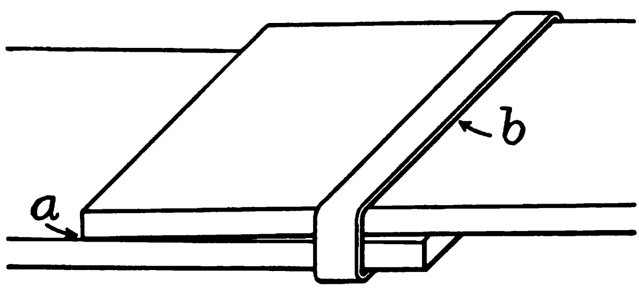

FIG. 88. CORRECT POSITION OF THE STEEL STRAP.
(It should be located near the end of the *lower* course of planking.)

The strap should not be placed at the center of the overlap of the planks, but should be shifted to

one side of this point, so as to take in the ends of the *lower* layer of planks with a margin of safety of from 4 to 6 inches. It is important to note that this is the most effective position that the strap can have, and that it would be worth very little if it were set so as to just include the ends of the *upper* planks.

If the putlog that ordinarily supports the platform at this point should fall, leaving the strap to sustain the total load, the planks would be subjected to a bending stress that would be particularly severe along the line marked *b*; and there would also be a considerable pressure between the upper and lower planks at their line of contact, *a*. The intensity of these stresses would depend in considerable measure upon the position of the strap, and would be least when the strap is placed as far away from *a* as possible. For example, all the stresses, both in the strap and in the planks, would be only about one-third as great if the strap were placed as shown in Fig. 88, as they would be if it were placed as indicated in Fig. 87, —the two diagrams being drawn to the same scale. It is evident, therefore, that under certain conditions the platform might be safely sustained if arranged as in Fig. 88, even though the stresses, with the disposition shown in Fig. 87, were severe enough to break the planks or the strap.

With the consecutive planks of the platform overlapping each other by two feet (that is, with each plank overlapping the putlog by one foot), a well-made strap of the dimensions suggested above, when placed in the position indicated in Fig. 88, would no doubt help to sustain the planking temporarily in the event of a suspension cable breaking, unless the

platform were carrying a load considerably in excess of the limit that should be permitted. It is not in actual use, so far as we are aware, and under ordinary circumstances it is not needed, because the scaffold can be made quite safe without it, by correct installation and careful inspection followed by the prompt and conscientious making of such changes and repairs as may be found to be needed. The strap is here suggested and described, however, because it might be advisable to adopt it in certain cases, where the failure of the scaffold would be likely to be followed by unusually serious consequences, either to the workmen or to persons on the street below. When made to the dimensions given above, it should weigh a little less than forty pounds.

130. Guard-rails, Foot-boards, and Side Screens. For preventing the fall of men, implements, or material, suspended scaffolds should be furnished with protective devices similar to those already described in connection with the bricklayers' pole scaffold. Each scaffold should have a stout wooden hand-rail (or breast-rail), set at a height of about 40 inches, and running along the entire length of the platform, above its outer edge. The rail should be made of sound material, and be free from bad knots and cross-grained spots. It should be securely fastened in position, and should be strong enough to resist, with perfect safety, the shock caused by a large man falling heavily against it. Rope is sometimes used in the place of the wooden railing here advised, but it is inferior from all points of view, except as regards convenience in transportation and installation. Even when the work is of such a nature that the platform must be

drawn up unevenly, rigid wooden rails can be used with entire success if they are made in sections of reasonable and convenient length. The platform of the scaffold can bend only at the putlogs, and there is no need of any trouble from lack of pliability in the railings if they are of the same length as the planks, and the successive sections are joined together in some flexible manner, opposite the suspension cables.

On a scaffold of the *overhead* type, where the machines are located on the thrust-outs or outriggers and the cables move with the platform, the hand-rail may be lashed directly to the suspension cables. It should preferably run *inside* of the cables, so that any shock to which the rail may be subjected will be resisted by direct pressure against the cables themselves, and not merely by the lashings or other fastenings by which the rail is attached to them.

In a scaffold of the *platform* type, where the machines are attached to the platform and move with it, the hand-rail cannot be conveniently secured directly to the cables, but must be made fast to some other part of the structure. In the particular form of platform scaffold described and discussed in paragraph 97, page 176, provision is made for the support of the guard-rail by riveting to the outer support of the machine that is used at the outer edge of the platform two perforated ears (*A* and *B* in Fig. 74), through which there passes an upright rod having at the top an eye (not shown in the engraving) to which the hand-rail can be lashed. For reasons similar to those given in the preceding paragraph, it is best to run this rail on the *inner* side of the iron supports, so that

any shock that may be thrown upon it will be transmitted to the supports by direct pressure, and not by means of tension upon the fastenings.

Along the outer margin of the platform of either type of scaffold, and in close contact with it, there should be a securely-supported foot-board, projecting at least 7 inches above the platform, for preventing tools and materials from falling over the edge. In the *overhead* type of scaffold the foot-board may be made fast to the suspension cables, and it should run *inside* of these cables. In the particular form of *platform* scaffold that we have discussed, each of the vertical rods that support the hand-rail has an offset near the bottom (*C* in Fig. 74), to hold the foot-board in place.

In addition to the hand-rail and the foot-board, it is highly desirable to provide a side screen of stout wire netting, extending from the hand-rail to the floor of the platform. In some localities a screen of this kind, or some equally effective substitute for it, is required by law. The screen should have a mesh small enough to prevent objects more than half an inch in diameter from passing through, and it should be securely attached to the hand-rail and also to the foot-board (or the platform), at intervals short enough to insure its safety and stability, even if it were subjected to a considerable impact or shock.

The foot-board is often omitted when the wire screen is used, but it is far better practice to install them both,—the screen serving to prevent the fall of men and large objects generally, while the foot-board serves to retain small implements and fragments of building material. Moreover, it is not always easy to make a tight joint between the wire screen and

FIG. 89. ILLUSTRATING THE USE OF WIRE NETTING FOR SIDE SHIELDS AND FOR OVERHEAD PROTECTION.
(See paragraphs 130 and 134.)

the platform when no foot-board is used. When both are adopted, it is preferable to have the screen rest against the inner side of the foot-board,—that is, against the side that faces the platform, as shown in Fig. 89.

At a corner, where two platforms come together at right angles, the corresponding guard-rails and foot-boards should be securely fastened together, and the wire netting should be passed around the corner in such a way as to give the same degree of security there that is afforded at any other point. If the suspension cables that are nearest the corner on the outside edges of the two platforms are not too far apart, it is often possible, by using specially stout and long material, to bring the ends of the guard-rails together and unite them by lashings, clamps, bolts, or nails, so that a safe and secure corner can be formed without the aid of a post; but if there is the slightest doubt as to the efficiency of the corner thus formed, the rails should be supported by a post, erected solidly and effectively, so that it cannot be overthrown by any shock to which it is likely to be subjected. We especially desire to emphasize the importance of *bracing this post with care*, because it is almost invariably either omitted altogether, or set up in the most insecure manner, so that it is practically useless for the purpose for which it is intended.

The guard-rail, foot-board, and wire screen should extend entirely across the platform, wherever it has a free end. In a suspended scaffold of the *overhead* type, the guard-rail and foot-board, where they cross the platform, can be made fast to the last pair of suspension cables, and the wire screen can be secured to

the rail and to the foot-board, just as it is along the side of the platform. When the scaffold is of the *platform* type, however, so that the suspension cables cannot be utilized for the direct attachment of the guard-rail or the foot-board, it may be necessary to erect a post for this purpose at the inner edge of the platform, and perhaps also at the outer edge. In such cases the posts should receive the same consideration that is recommended in the last paragraph, and should be solidly braced and made capable of safely withstanding a heavy shock.

In using a suspended scaffold it is all too common to slight the guard-rails, foot-boards, and wire netting. In many cases the netting and the foot-board are omitted (as in Fig. 76), and the guard-rail is often erected in a weak and altogether inadequate way, or is entirely absent. It is hardly necessary to say that this is all wrong. The expense involved in providing these safeguards and having them right is trivial, and it is hard to see what sufficient reason a builder can give for failing to install them, in a safe and substantial way. When properly constructed they are very effective in saving life and limb, and in many places they are also required by law.

131. Protection of Scaffold from the Fall of Objects from Above. Workers upon swinging scaffolds are often left wholly unprotected against injury from the fall of objects from above. We are glad to note, however, that builders are coming to see the wisdom of providing such protection, in cases in which there is danger from this source. There is no special difficulty involved, the main question being that of expense.

It is hardly possible to arrange a scaffold of any kind so that the men at work upon it will be protected from injury in case of the fall of a heavy mass like a beam or a large stone. Many accidents occur, however, from the fall of small objects such as rivets, bricks, or tools, against which the men can easily be shielded. Protection against the fall of massive objects should be insured by adopting general precautionary measures in connection with the management of the work as a whole, rather than by relying upon special safeguards associated with the scaffold itself. Beams and other heavy masses, for example, should never be suspended, even momentarily, over any scaffold upon which men are at work. It is not sufficient to keep the platform clear of workmen immediately under the beam, because in the event of an accident through the failure of the hoisting apparatus, the whole scaffold might be wrecked.

When used in connection with a suspended scaffold of the overhead type, a roof or covering for shielding the men from falling tools or other small objects may be secured directly to the cables that support the platform. This plan works very well upon buildings not higher than the length of the suspension cables of the scaffold. It is less convenient, however, when the level of the thrust-outs has to be changed during the progress of the work, because the suspension cables must be disconnected in order to shift the machines, and this means that the protective covering must also be temporarily removed, if it is attached to the cables themselves.

132. Canvas Shields over the Platform. Stout canvas is sometimes used for the protective cover,

FIG. 90. SUSPENDED SCAFFOLD (PLATFORM TYPE) WITH OVERHEAD SHIELD OF CANVAS.

(This particular shield could be greatly improved, by attending to the suggestions given in paragraph 132.)

though in many respects it is not an ideal material. When it is used it should stand, at its lowest point, from three to six feet (according to the tension to which it is subjected) above the heads of the men who are to be protected; because an object falling upon a canvas surface may depress it by a considerable amount before being brought to rest, and ample provision for such depression should be made in fixing the height. (The shield shown in Fig. 90 is too low to afford full protection.)

The canvas that is used should be quite heavy, that known as "No. 6 duck" being usually considered best. This may be had in many widths, the most useful width being either 48 inches, 60 inches, or 72 inches. It should be reinforced along the edges by sewing on extra strips of similar canvas, and rings should be worked in it at frequent intervals along each edge, to receive the fastening ropes. Grommets will serve in the place of rings, but they are not so good. Stretch the canvas fairly tight, and do not set it horizontally, but incline it sufficiently to cause it to shed water easily, the outer edge being the lower. The shield should be made fast with half-inch hemp rope, this being better than a larger size because it will yield and stretch more readily when the canvas shrinks through becoming wet.

The edges of the canvas should be supported at intervals of not more than five feet. When the machine is of the overhead type and the shield is secured to the suspension cables (which are commonly 10 feet apart), its edges should therefore be supported midway between the cables. This may be effected most conveniently by running a half-inch rope diagonally upward from the

middle point of each free edge to each of the two nearest cables, and making the ropes fast to the cables at a height of six feet or more above the canvas. (They may be attached while the cables are slack,—that is, before raising the platform,—and disconnected again from the thrust-outs overhead.)

To strengthen and stiffen the canvas so that it will be better able to resist the action of the wind, it is advisable to sew two or three ropes to it along its entire length. These should run lengthwise of the platform, and should be spaced at equal distances between the edges of the shield. Thus if two stiffening ropes are used, one of them should be secured at one-third of the width of the canvas from each edge; and if three are used, one should lie along the middle of the shield, and the other two should come midway between this central rope and the respective edges.

The cost of a properly-made canvas shield is quite considerable, and this fact, taken in connection with the difficulty of handling and supporting such a shield and the admitted fact that canvas is far from ideal in other respects also, indicates that under most circumstances it is better to substitute for it a protective roof of wire netting or of wood, substantially supported in whatever way appears best adapted to the type of the scaffold, and to the conditions under which it is to be used.

133. Plank Roofs for Overhead Protection. When an overhead protective shield is desired for a suspended scaffold of the *platform* type, in which the drums that wind up the suspension cables are located upon the platform itself, the support of the shield calls for special consideration. In a scaffold of the

overhead type the suspension cables move with the platform, and the shield can therefore be secured to them, directly and permanently, without trouble; but in the platform type the platform moves while

FIG. 91. PLATFORM-TYPE SCAFFOLD, WITH OVERHEAD PROTECTION OF PLANKS SUPPORTED BY A SPECIAL STEEL FRAMEWORK.

the cables remain stationary, and hence when using a scaffold of this kind the overhead shield must either be shifted on the cables from time to time, or supported by a separate framework of some kind as in Fig. 91.

In view of this difficulty a double platform is sometimes used, one layer of planks being 7 or 8 feet above the other. (Fig. 92 illustrates this construction, although the particular scaffold there shown contains numerous objectionable features, as will appear from the suggestions that follow.) Each plank layer is supported by its own putlogs, the putlogs of the upper platform being set directly over those of the lower one. The lower putlogs are suspended individually from the upper ones by means of separate short lengths of cable, which do not have to be disturbed, even when changing the positions of the thrust-outs. The workmen stand upon the lower platform, and the upper one affords them the desired protection.

In using a double platform of this character, the suspension cables (in the *overhead* type of scaffold) and the machines (in the *platform* type) should be secured to the upper platform, precisely as though this were the only platform present. In other words, a suspended scaffold having a double platform should be constructed so that if the short cables supporting the lower layer of planking were cut away, the remaining parts would constitute a single-platform scaffold conforming in all respects to the construction advised for such a scaffold in this treatise.

Care must be taken to have the fastenings by which the lower platform is hung from the upper one equal in strength, in every way, to the suspension by

which the upper one is supported from the thrust-outs. It is recommended that the short cables which join the two platforms be provided with a well-made spliced eye at each end. The bolts that unite the two

FIG. 92. SMALL DOUBLE-PLATFORM SCAFFOLD OF THE PLATFORM TYPE.

(Note the absence of the guard-rail and wire screen at the end. See also the text.)

angle-irons of which each putlog is composed can then be passed through these eyes, giving solid connections to both platforms. When the putlogs are not composed of double angle-irons, or when, for any other reason, the eyes of the short cables cannot readily be secured to the putlogs directly, rectangular yokes may be used to make the connection, these being slipped over the putlogs, just as they are slipped over the thrust-outs in attaching the upper ends of the main suspension cables of a platform-type scaffold.

In the double-platform scaffold the men work upon the lower platform. If the scaffold is of the overhead type, there will be no need of anyone going out upon the upper layer of planking, except when it becomes necessary to shift the thrust-outs to a higher level, in the course of the erection of the wall. If the scaffold is of the *platform* type, however, the men whose duty it is to raise the scaffold from time to time must go out upon the upper platform to operate the machines, and a railing and foot-board should therefore be provided on the upper platform in such cases. Wire netting is also recommended, though the hand-rail and foot-board will ordinarily be quite sufficient in this place. Whichever type of scaffold is used, it is important to see that the lower platform, where the workmen are, is fitted up with substantial guard-rails, foot-boards, and wire netting, in strict accordance with the standard that is described above in paragraph 130, and recommended for use upon single-platform scaffolds.

Whenever, in using a double-platform scaffold, it becomes necessary for a man to pass from either of the platforms to the other one, he should not be

permitted to climb over the outer edge of the scaffold, nor over one of its free ends. He should be required to use a ladder placed so that it is easily accessible from both platforms, or else to pass into the building from the platform that he is leaving, and out from the building again at the proper level, to the platform that he wishes to reach. When neither of these methods is feasible, the two platforms may be connected by a special ladder, either entirely inclosed or at least provided with a back-bar, to make the passage from one level to the other safe. It would seldom be worth while to go to this trouble, however, because the wire-netting shield described in the next paragraph is far cheaper, lighter, and more practical, and it suffices for nearly all conditions.

134. Overhead Protection by Wire Netting. Unless protection is desired even against very small particles of material, an overhead shield of wire netting, similar to the side screens that were discussed in paragraph 130, is very effective. A screen of stout wire, with a mesh *not exceeding half an inch* each way, will prevent the passage of almost any object that would be likely to injure the workers. Such a screen has various advantages. It weighs far less than a plank covering, and it is not seriously disturbed (as a canvas covering is likely to be) by strong winds. Moreover, it has the advantage that it allows light to pass through it freely. Most of the injuries that occur on suspended scaffolds from the fall of materials from above are caused by rivets, bolts, drift-pins, or the various hand tools that the steel men use. Wire netting is quite effective in stopping objects of this kind, if it is made of stout wire

with a mesh not more than half an inch square, as already suggested. The wires of such a screen should be soldered together at every crossing.

Fig. 89 shows an overhead screen of this kind in use on a suspended scaffold of the overhead type, and Fig. 93 gives a different view of the same screen. In the case here illustrated horizontal wooden stringers were run parallel to the face of the building, and secured to the outer and inner rows of suspension cables, respectively, at a height of about 8 feet above

FIG. 93. A SCAFFOLD PLATFORM WITH AN OVERHEAD PROTECTION OF WIRE NETTING.

the platform. Wooden cross-pieces were then laid upon the stringers to support the wire-mesh screen, which was fastened in place securely enough to be safe against any chance of displacement, by the wind or otherwise. When a protective screen of this kind is to be used on a scaffold of the platform type, it is best to support it by means of a special framework, similar to the one shown in Fig. 91 for supporting the plank covering. This framework can be held in position by the suspension cables without being actually fastened to them, the cables being run through openings in the framework or through ears attached to it, the whole being arranged so that the framework can slide freely along the cables as the platform is raised.

135. One Scaffold Over Another. Two or more entirely separate suspended scaffolds are sometimes employed simultaneously upon the same job, one of them at a higher level than the other. In cases of this kind it is highly important to protect the men upon the lower scaffold from materials, tools, or other objects that may fall from the upper one. Such protection may be had either by providing the lower scaffold with a protective roof such as has been described above,— or, still better, by arranging a fixed protective shield or platform at some level between the two scaffolds. The latter plan may be put into effect quite easily, when the scaffold machines are of the platform type, by laying a flooring of stout planks over the thrust-outs from which the lower scaffold is suspended. (See Fig. 94.) A flooring of this kind may be made very effective, so far as concerns the protection of the lower scaffold from materials (even from heavy planks) falling from the upper one; but it

FIG. 94. TWO SCAFFOLDS IN USE AT THE SAME TIME, ONE ABOVE THE OTHER.

(The thrust-outs that support the lower scaffold are covered with a layer of planks, to protect the men on the lower platform.)

should not be forgotten that it does not protect the lower scaffold from objects falling from points lower than the outriggers or thrust-outs upon which the planking is laid.

When a plank floor is placed upon a tier of outriggers as here described, care should be taken to lay the planks securely, and to see that they overlap by a very considerable amount, both upon themselves and upon the outriggers. Floors of this kind should be examined frequently, and especially after storms or high winds, to see that they remain in safe condition; and it is wisest to lash the planks to the outriggers, or to make them fast in some other effective way, so that there may be no question of their security. The planks should always rest upon the upper sides of the outriggers, and should never be lashed against their under sides.

136. Shifting the Thrust-outs. The suspension cables upon scaffold machines of either type are usually from 75 to 100 feet in length. When the building to be erected is higher than the length of one cable, the thrust-outs are first set at a height somewhat less than the length of a cable, and the scaffold is raised in the usual manner, as the work progresses, until it comes near to the thrust-outs from which it is supported. New thrust-outs are then placed at a higher level, and the cables are shifted to them. When this has been done the old thrust-outs are removed, and the work proceeds as before,—the thrust-outs being shifted in this way every time the height of the wall has increased by approximately one cable length.

The shift from one set of thrust-outs to the next should be made with special care, because accidents

are quite likely to occur in this part of the work unless it is superintended by a person who understands it thoroughly. The builders of scaffold machines often specify, in leasing them, that they shall be notified when it is necessary to make the shift, so that they can send trained men of their own to supervise the work; and we strongly advise that this be done whenever it is feasible. It is not necessary to clear the platforms of material while the change is being made, but the workmen should be required to withdraw from the sections that are being shifted, so that in case of accident the results will not be needlessly serious.

In changing the position of the outriggers upon either type of scaffold, the new outriggers are first set in place, and the platform is then raised to within 8 or 10 feet of the old ones and securely lashed to them, or fastened to them in some other perfectly safe way, so that when the main suspension cables are disconnected the platform will still be supported safely, and with no possibility of a fall. The drums upon which the main cables are wound up should then be reversed or backed away slightly, so as to throw the entire weight of the scaffold upon the lashings or other temporary connections, and render the main suspension cables slack. It is important that this slacking-up should be done, and done carefully, so that in subsequently disconnecting the main cables there will be no sudden jar or shock thrown either upon the scaffold or upon any of its connections.

When the suspension cables have thus been rendered slack, they are disconnected from the putlogs (if the scaffold is of the overhead type), and the machines are drawn in and transferred to the newly

installed thrust-outs at the higher level. Their cables are then lowered and again made fast to the platform putlogs, precisely as described above in paragraph 121, where the first installation of a scaffold of this type is discussed.

If the scaffold is of the platform type the procedure is much the same, except in regard to such details as will readily suggest themselves. When the platform has been made fast to the lower thrust-outs and the drums have been slowly and carefully eased back so as to throw the weight of the platform upon the lashings or other temporary connections and render the main suspension cables slack, these main cables are disconnected from the old thrust-outs and drawn up to the new ones above, and there made fast in the usual manner,—as already described in paragraph 108, where the installation of this type of machine is described. To facilitate the drawing-up of the suspension cables of platform-type machines it is customary to fasten the pawls of the machines with wire, in such a way that they will remain clear of their ratchets while the cables are unwinding from the drums. This may not be regarded as ideal practice, because it suggests the possibility of forgetting the wire on some of the pawls, and attempting to restore the scaffold to use with these pawls out of action. An oversight of this kind would not be likely to occur in actual work, however, because the temporary lashings could not be slacked up, as described in the next paragraph, unless the pawls were properly engaging the teeth of their ratchet-wheels; but if it should be considered undesirable to fasten the pawls back in this way or in any other way, they can be held out of mesh by the men while the cables are unwound from the drums.

Whichever type of scaffold is used, the next step, after the connections have been properly and safely made to the new thrust-outs, is to raise the platform by turning the drums in the usual way until the load is again supported entirely by the main cables, and the temporary lashings or supports are slack. The temporary lashings are then removed, the old thrust-outs are taken away, and the scaffold is ready for use.

The method of shifting described above assumes that extra thrust-outs are available. If this is not the case temporary beams may be arranged to support the scaffold while the thrust-outs are changed. The necessary modifications in the procedure will be evident enough without special description. The same precautions should be observed, in making the shift in this way, that are recommended, above, in connection with the use of the extra thrust-outs. Special care should also be taken to secure the temporary beams safely and solidly to the building.

Nobody, save those who are necessarily employed in the shifting of the thrust-outs, should be allowed to go out upon the platform until the old thrust-outs have been disconnected and drawn back into the building. It is a mistake, for example, to permit bricklayers or their helpers to return to their work upon the platform, while the men who have been shifting the scaffold are still engaged in removing the old thrust-outs, over their heads.

137. Comparison of the Overhead and Platform Scaffolds. The platform type of suspended scaffold is easier to install than the overhead type, but many builders prefer the overhead type because it leaves the platform entirely free from machinery of any

kind, so that every square foot of it can be utilized by the workmen. The overhead style is particularly convenient for use, too, when it is necessary to lower the scaffold from time to time, because it can be lowered by merely reversing the direction in which the hand-rope or driving-rope is pulled. In the particular type of platform machine that is herein discussed, however, the platform can be lowered only by raising the pawls alternately, by hand. In performing this operation the operating lever of the machine is first depressed sufficiently to bring the total load upon its pawl. The other pawl is then held out of mesh while the lever is eased up by one stroke, after which the

FIG. 95. THE "PERFECT" SCAFFOLD MACHINE.

fixed pawl is allowed to fall back into place. The load being then transferred to the fixed pawl, the lever pawl is in turn held out of mesh, and the lever is swung down to its lowest position, its pawl being thereafter released and allowed to re-enter the ratchet. This entire process is repeated, again and again, until the platform has been lowered as far as desired.

It should not be inferred, from what has been said, that all platform machines are actuated by pawls and ratchet-wheels. Fig. 95, for example, shows a form in which the drum is controlled by a worm. When using this type the platform can be reversed and lowered as easily as in the overhead machines, by merely reversing the motion of the operating handle, which is attached to the worm-spindle shown at *A* in the engraving. A full discussion of these points of difference, with a view to bringing out the relative merits and demerits of the various designs of machines that are actually made and available, would require a prohibitive space. Moreover, such discussion would not be entirely consonant with the purpose of this work, which, as explained in the preface, is merely a treatise on the principles of safety engineering as applied to scaffold work, rather than upon scaffold work as a whole; and to illustrate these principles it is not necessary to take up every form of scaffold machine in detail.

138. Cornice Work. The cornice of a building sometimes presents troublesome problems when suspended scaffolds are used. This is particularly the case when the cornice projects outward to a considerable distance. In such a case the scaffold may be removed before the cornice is completed, or small

openings may be left in the cornice for the suspension cables, the cables being drawn out through these openings when the work has been completed and the scaffold is to be taken down.

In erecting a cornice with the aid of a suspended scaffold there is often a temptation to allow too great a stress to be thrown upon the scaffold platform, not only by loading it improperly with materials but also by lifting heavy objects in such a way that the men or the jacks that are used for this purpose rest upon the scaffold platform, and so transmit to it the weight of the object lifted. Special care should be taken to avoid anything of this kind, because although the scaffold is supposed to be strong enough to safely support any load to which it may be legitimately subjected in the course of the ordinary routine work, it is not intended to sustain the uncertain and perhaps quite severe additional stresses that may be thrown upon it in the ways indicated, or in other similar ways that were not contemplated by the designers of the scaffold.

139. Life Lines and Safety Belts. The men who have to secure or shift the thrust-outs for the support of suspended scaffolds, and particularly those who have to adjust or inspect overhead machines or attach the upper ends of the cables of platform-type machines, must crawl out upon the thrust-outs to a greater or lesser extent, and be thereby exposed to loss of life through falling. A stout life-belt should therefore be provided for every man who must go out upon a thrust-out,—the belt being securely attached to a strong, new rope, the end of which should be made fast to some part of the framework of the building (prefer-

ably not to the thrust-out itself) before the man is permitted to go out upon the thrust-out. The rope should be no longer than is necessary in order to permit the work to be done without inconvenience, because if it were needlessly long the fall of the man would subject it to a snapping stress of unnecessary severity, and it would be more likely to break than it would be if it were shorter.

Lifelines are in common use in Germany and England for work similar to that described above, but they are seldom seen in the United States, where it is often hard to induce the workmen to wear them even when they are provided, unless some person in authority stands by and insists upon it.

No man should be permitted to go out upon a thrust-out, except for some definite object the attainment of which appears to be worth the chances that are involved; and even in this case no one should be permitted to do so except the man or men designated for the purpose by the foreman in charge of the work.

140. Inspection of Suspended Scaffolds. One of the conditions most essential to safety in the use of a suspended scaffold is the careful inspection of its parts, both before the scaffold is erected and while it is in service. The builder usually leases the scaffold that he is to use, instead of owning it himself. This is believed to be the best practice, because scaffold machines are mechanical devices of a very special kind, and they can best be inspected and kept in proper condition by a concern that makes a business of doing this one particular thing. The company owning the scaffold machine furnishes all of the parts that are essential to the erection of the scaffold, with

the exception of the planking and other wooden portions, and the side shields and top shields. It would be much better, in most cases, for the same concern to furnish everything complete,—wooden parts and all,—installing the scaffold ready for use in all respects, with its hand-rails, foot-boards, and wire netting (or other equivalent) in place.

A scaffold that has been used should never be put in service again until it has been carefully inspected in every part. The cables should be unwound from the drums and examined at every point, to see if any of their strands have become broken, or if they have become unduly worn or damaged in any other way. The fastenings at the ends of the cables should be particularly examined, to see that they are in good condition. Every nut and bolt should be inspected also, to see that it is tight and sound. In a word, every portion of every machine should be gone over carefully and conscientiously, and have its condition thoroughly investigated in every detail, before the scaffold is used on another job. It is impossible to throw too great an emphasis upon the importance of this inspection service, and builders who hire scaffolds should assure themselves in every case not only that the inspection has been made, but also that it has been made by a man skilled in work of this kind. A considerable proportion of the accidents that have occurred upon the suspended scaffolds that are used in construction work have doubtless been due to neglect in this respect, or to neglect in replacing or repairing parts that the inspection may have shown to be faulty.

The scaffold should also be inspected at frequent intervals while it is in service, to see that it is in good

condition at all points, so far as can be determined in this way. (See also paragraph 155.) In making these inspections, particular attention should be paid to the positions and fastenings of the thrust-outs, to the general condition of the machines, to the visible parts of the suspension cables (and particularly to their ends, where these can be seen), to the planking of the platforms, and to the protective hand-rails, foot-boards, and wire netting. The inspection of the scaffold while it is in service should likewise include an examination of those parts of the building that are higher than the scaffold, and near to the plane of the wall that is going up. Heavy objects should not be stored in such places, nor should piles of brick or other materials be allowed to stand where they may possibly be overthrown in such a way as to fall down upon the scaffold.

XI. SCAFFOLDS OF OTHER KINDS.

141. General Remarks. It is unnecessary to discuss every form of scaffold with the same degree of detail that we have given to the forms that have been described up to this point, because the same general principles apply in all cases, and minute description and discussion would therefore involve much useless repetition. Moreover it would be impossible to take all forms of scaffolds into account, not only because they are used for an exceedingly great variety of special purposes, but also because the different forms often shade into one another by modifications that are slight and even non-essential. In the present section, however, we shall take up a few forms that it appears to be desirable to mention explicitly,—calling attention to certain points in connection with them that have a special relation to the safety problem.

142. "Outrigger" Scaffolds. In scaffolds of this kind the characteristic and essential feature is the support of the platform by outwardly-projecting beams (called "thrust-outs", "outriggers", "jibs", "cantilevers", "bearers", and various other names), that are supported in some safe way,—preferably by framework and bracing, inside of the building. The protective platform illustrated in Figs. 57, 58, and 59 is a structure of this kind, though it would not ordinarily be called a scaffold, because it is not intended for the support of men or materials. Further examples are shown on the

left of Fig. 4, on the right of Fig. 7, and in Fig. 68. In the "outrigger" or "thrust-out" scaffold the platform is either laid directly upon the thrust-outs, or supported from them immediately and without the intervention of any considerable space or sustaining mechanism. The suspended scaffolds that are used in construction work on high steel-framed buildings, and which are described in this work from page 168 to page 210, are not usually classed as outrigger scaffolds, because although they are supported by beams that are thrust out from the building, they are of such a special design that they constitute a class by themselves.

The sustaining beams of an outrigger scaffold should never be merely built into the wall and left without other support. They should always project entirely through openings in the wall, or through windows, and be solidly and properly supported and braced on the inside of the building. External struts and braces should be used wherever they may be needed to provide additional strength or stiffness, but it is unwise to place any great reliance upon external support of this kind, unless the construction is exceptionally well-designed and strong. Some engineers approve of external bracing for the main support, if it is secured to iron dogs or spikes that are driven into stone walls and solidly wedged; but a construction of this kind involves so many uncertainties that we strongly advocate a more positive method of support.

It is exceedingly important, in all cases, to use nothing but the best material for the thrust-outs. They should be strong enough, when considered as beams supported at one end, to sustain, with a factor of safety of at least ten, the heaviest load to which they will be

subjected; and the same consideration, in this respect, should also be paid to the various supports and fastenings upon which the security of the scaffold depends.

The thrust-outs should be rigidly held, so that no displacement of them will be possible, in any direction. Builders often fail to make proper provision for guarding them against sidewise displacement, even when they are well supported so far as direct vertical failure is concerned. Outriggers having a rectangular cross-section should rest on their edges, because they have the greatest strength in that position; and they should be secured so that they cannot turn over on their sides while in service, not only because they would then be weaker when considered as beams, but also because the shock to which the scaffold would be subjected by a sudden overturning of this kind would throw a severe stress upon the whole structure, and perhaps cause it to give way.

FIG. 96. INTERIOR SUPPORTS OF AN OUTRIGGER SCAFFOLD.
(From the new German Museum building, Munich.)

Fig. 96 shows the interior supports of a thrust-out scaffold that was used in the construction of the new German Museum building at Munich, and illustrates the commendable thoroughness with which the supporting work was designed and installed. The platform of the scaffold, which cannot be seen in the engraving because it was outside of the building, was substantially on a level with the tops of the window openings.

Fig. 97 shows a church spire, surrounded with an extensive scaffold resting upon outriggers set at or near the base of the tapered part of the spire. Work of this kind should never be attempted by anybody but an expert in scaffold construction, and the outriggers that support the structure should be selected and placed with special care. Steel outriggers are preferable to wooden ones, in such cases, on account of their superior strength; and they should run completely through the spire, from side to side. It is often difficult and always expensive to obtain sound wooden beams of proper size and strength for purposes of this kind.

Hand-rails and toe-boards, or other protective devices equivalent to them, are as important on thrust-out scaffolds that are to be used by workmen as they are on scaffolds of other forms that are situated at similar heights. There is seldom any special difficulty in providing safeguards of this kind, and there is correspondingly little excuse for omitting them. Fig. 98 shows an outrigger scaffold that was well constructed and supported, and which was provided also with two guard-rails, a foot-board, and a side screen of wire netting. The platforms of outrigger scaffolds are frequently built with tight board fences along their

outer edges, so that neither men nor materials can fall from them. (See, for example, Fig. 119 on page 300, which shows a protective scaffold supported by outriggers.)

FIG. 97. FRAMEWORK SCAFFOLD SUPPORTED BY OUTRIGGERS.

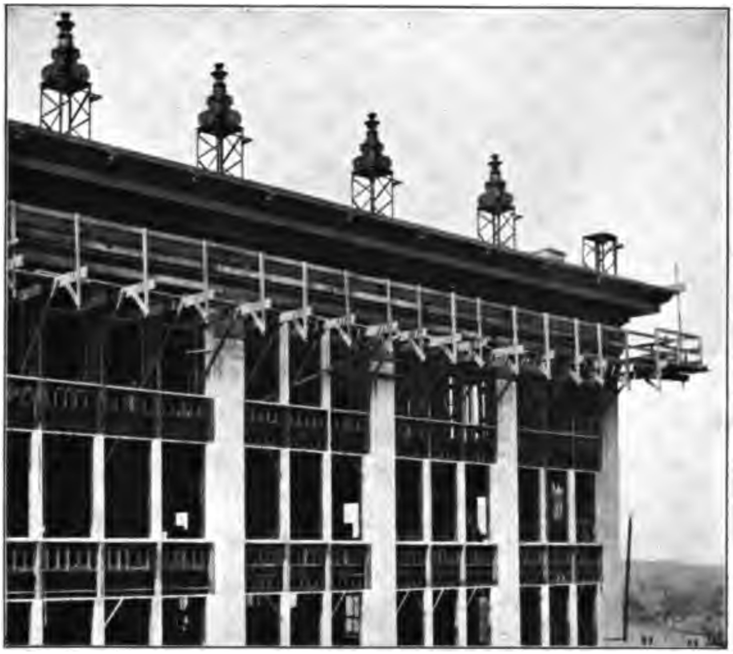

FIG. 98. A WELL-CONSTRUCTED OUTRIGGER SCAFFOLD.

As pointed out in paragraphs 75 and 149, outrigger scaffolds may often be used to advantage as protective roofs over passageways or workplaces, and as "catch-platforms" to prevent the fall of materials upon persons at lower levels, or to prevent fatal consequences in case workmen should fall from another platform or workplace at a somewhat greater height. They are also useful for roofers, tinners, painters, or carpenters, when doing light work on cornices or gutters or in other elevated places. Nevertheless, we do not advise the use of outrigger scaffolds for the support of workmen when some other form can be used with equal advantage, because although they can be made quite safe, it often happens that the men who

are charged with erecting them do not thoroughly understand the mechanical principles that are involved, or do not take the time or trouble to do the work with proper thoroughness.

When outrigger scaffolds are to be employed they should be carefully inspected, before they are used, by a competent, painstaking man, who understands just what is required and who has authority to have every weak or doubtful element in the construction replaced or strengthened. Scaffolds of this kind should never be used for supporting heavy loads, unless they have been designed and built with special reference to such loads, under the direction of a person who is competent to calculate the stresses that will be thrown upon them in every part, and who has investigated these stresses, and provided for them, with all the care that would be exercised in connection with a permanent structure.

In placing the thrust-outs of an outrigger scaffold, and in laying upon them the planking or other superstructure that they may have to support, the greatest care should always be taken to protect the men from falling, and to prevent accidents from the fall of materials or of parts of the scaffold. The same counsel applies, also, to the dismantling of such scaffolds.

143. Carpenters' Scaffolds. Carpenters make use of scaffolds of various kinds, the most familiar and distinctive of which consists of a platform of boards, supported by brackets or "jacks" that are secured to the side of the building. Fig. 99 shows a well-designed bracket for a scaffold of this kind that is to be used in ordinary work, where no great weight has to be supported. In using a jack of this kind, carpenters sometimes pass the supporting bolt merely through the

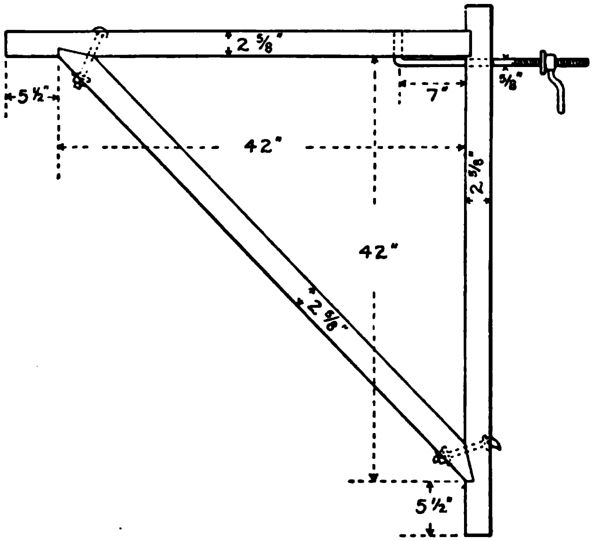

FIG. 99. A CARPENTERS' BRACKET OR "JACK."
(Each piece is 1¾ in., full, in thickness. Selected spruce is recommended.)

outer sheathing of the building, placing entire reliance upon the holding power of the nails by which the sheathing is attached to the studding. This practice is unsafe. To support the bracket properly, a block should be laid across the space between two consecutive vertical studs, so as to rest against them on the inside; and the bolt should then be passed not only through the sheathing but also through the block, the nut of the bolt being screwed down solidly against the block with a substantial washer between. The tension on the supporting bolt is thus transferred directly to the studs, and a correspondingly greater degree of safety is assured.

The bracket should have its supporting bolt near the top, and the threads should be in good condition both on the bolt and on the nut. The bolt should be of generous size, and long enough to go through the

sheathing and be secured in the manner recommended above, and to project for at least a couple of inches beyond the nut when the bracket has been secured in position. The nut should also fit tightly on the thread, so that it cannot work loose while the scaffold is in service.

The material that is used in the scaffold should be first-class throughout, in all respects. This point does not always receive the attention that it merits, and the men are often tempted to use inferior material for the scaffold, and to put the better stock into the building. It is much better and safer to reverse the procedure, and put the poorer material into the building. The brackets and platform-boards should both be exceptionally sound and strong, and when they have become deteriorated from protracted use or from exposure to the weather, they should be discarded and replaced by new ones. Brackets that have become broken or otherwise damaged or weakened are often seen in use, but it is poor economy to continue them in service when they are in bad condition, and many serious accidents result from following this course.

It is very common indeed for carpenters to lay the platform boards of scaffolds so that they project over the brackets and form what are known as "traps". This name refers to the analogy between such platforms and certain forms of animal traps, in which the victim is led to step upon a surface that is apparently safe, but which immediately tips under his weight and allows him to fall into an inclosure. Every possibility of this kind should be carefully avoided, by laying the platform so that no board projects over a bracket, at either end, by more than six or eight inches, without

support. Fig. 100 illustrates what may be called a "blind trap". A man walking along a platform laid in this way could easily be deceived as to the positions of the supporting brackets, and might therefore be led to step with firmness and confidence upon exceedingly dangerous places.

In addition to avoiding traps, it is important to have the platforms thick enough to prevent any considerable amount of springiness, or yielding, near the middle points of the boards. The yielding can be prevented in large measure by setting the supporting

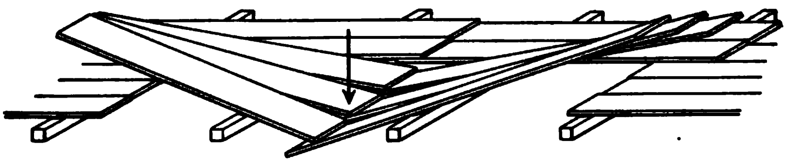

FIG. 100. ILLUSTRATING A "BLIND TRAP" ON A CARPENTERS' SCAFFOLD.

(The boards overlap, as will be seen, midway between two brackets, instead of squarely upon one of the brackets. A man stepping on the platform, where indicated by the arrow, would fall down through it.)

brackets near together. There should be three brackets under each board, and two layers of boards should be used, if necessary, in order to obtain the necessary rigidity in the platform. The boards should be laid snugly together so that there will be no room for tools or materials to fall down between them.

Guard-rails are seldom used on carpenters' scaffolds, although there is no special difficulty in designing a bracket that will afford good support to a guard-rail. When the bracket is of the ordinary construction an outwardly-projecting piece may be tacked along its horizontal leg, and then, by means of a diagonal brace set at an angle of about 45 degrees, a good substantial

support can be had for the railing and for a foot-board also.

For shingling and roofing, angle brackets (also known as "jacks" or "cripples") are often used, having sharp points that are thrust into the roof to prevent sliding. It is much safer, however, to support the brackets by means of ropes passing over the ridgepole of the building. When dependence is placed upon pointed projections to hold the brackets in position, see that the points are secure and in good condition, and that they penetrate to their full length in the woodwork of the building. If ropes are used, see that they are strongly fastened, not only to the scaffold brackets but also to substantial projections such as chimneys or cupolas, or to solidly-fixed objects on the further side of the building. They may also be secured by means of bolts having a diameter of not less than 5/8 of an inch, provided at one end with a long wood-screw to screw into the timbers, and at the other end with a strong, well-shaped eye for receiving the rope. If eyebolts are used in this way, they should be solidly screwed into sound, heavy timbers, and not merely screwed through a thickness of board.

When ropes are used in any of these ways, it is important to be sure that they are in good condition in every respect, and that they do not catch upon projections from which they may become loosened while in service, so as to let the scaffold drop by even a short distance, with a resulting chance of precipitating the workmen to the ground.

In laying shingles, carpenters often work without the aid of brackets, relying for support upon horizontally-placed pieces of scantling arranged as follows.

A long piece of material, about 2 inches by 4 inches in section, has several shingles securely nailed to it at different parts of its length, in such a way that the butt of each shingle comes flush with the edge of the scantling. The whole thing is then turned over so that the shingles come next to the roof, and each shingle is nailed solidly to the building so that the upper edge of the scantling coincides with the lower edge of the next course of shingles. The men rely upon these pieces of scantling for support, and the work proceeds until shingles have been laid to such a height that convenience requires another strip to be placed in position in like manner. In removing the strips of scantling after the work is completed, some carpenters merely cut off the shingles to which they are nailed, leaving the thin upper ends of these shingles in position. This cannot be regarded as first-class practice, however, because it leaves slight bulges on the roof. To overcome this objection, the shingles that served to support the scantling are often removed by striking them sharply to the right and left, so as to break the hold of the nails by which they are secured to the roof,—after which they can usually be removed without difficulty. The rough work of extracting the shingles is likely to loosen other shingles in the vicinity, however, and for this reason many carpenters now nail the scantlings to the roof by means of strips of sheet zinc. When the shingling is finished the zinc strips are cut off flush with the edges of the shingles that overlap them, and left in position. They do no harm, because they are too thin to cause the overlapping shingles to stand up to any sensible extent from those below. The cost of the zinc is not a serious element, and at the usual price

of the metal it need not amount to more than about one dollar to every hundred thousand shingles.

Crawling-boards (known also as "step-boards", "chicken-ladders", or "duck-ladders") should be used wherever they will tend to promote safety. A crawling-board consists of a board, preferably 9 inches or more in width and at least 1 1/4 inches thick, to which conveniently-spaced cross-strips are nailed, each about 1 1/2 inches wide and 1 inch thick. It is laid upon the roof so that its length extends from the ridge-pole down toward the eaves, and is used to assist the workmen in passing from one part of the roof to another. Crawling-boards should be securely fastened, so that they cannot become loose and slide down the roof. It is best to make them double, as shown in Fig. 105, and to lay them across the roof with the hinge at the peak or ridge-pole as there indicated. They may likewise be secured by hooks attached to them at their upper ends, and arranged so as to reach over the peak of the roof and seize the building on the other slope. They are also made with thick, solidly-fastened cleats on the under side, at the upper end, to hook over the peak, or with one or more bolts projecting through the upper ends, to catch over the peak in like manner. If a cleat or bolt is used, we advise nailing the crawling-board down at the upper end, in addition, to remove all possibility of the board or the bolt becoming displaced in an upward direction, sufficiently to loosen the hold.

When a considerable amount of work is to be done on a steep roof having an average height of more than 20 feet (as measured from the ground to the eaves), it is exceedingly important to provide a catch-platform or some equivalent device, to save the men from injury

in case the brackets on the roof give way or any other accident occurs. If the roof has a parapet at the eaves, the protection afforded in this way may be quite sufficient; or if there is a pole scaffold or other scaffold already standing by the side of the building, and having a wide, substantial, well-supported, and well-guarded platform at the eaves or immediately below them, this should afford satisfactory protection. If neither of these conditions is fulfilled, a special protective platform of some kind should be provided at the eaves or slightly below them. A thrust-out scaffold, securely supported, with a platform about 45 inches wide located not more than 30 inches below the eaves, is satisfactory for this purpose, if properly provided with guard-rails and foot-boards. (See also paragraphs 142 and 149.)

When the work to be done on the roof is not extensive enough to justify the labor and expense involved in erecting a special protective platform at the eaves, or when for any other special reason it is deemed inexpedient to construct such a platform, the workmen should be provided with strong life lines, securely attached to fixed parts of the building. (See paragraph 139.)

The forms of scaffold that are used by carpenters for interior work do not differ sufficiently from those employed by plasterers and decorators, and described in paragraph 146, to call for separate description and discussion.

144. Painters' Swinging Scaffolds. The painters' swinging scaffold in its typical form consists of a short, light platform, supported at the ends by ropes that are attached to the building at the eaves or at some other

elevated point. The platform often consists of boards laid upon a horizontal ladder of special construction,—its side-bars being parallel and somewhat further apart than usual. Each end of the ladder is supported by an iron stirrup or hanger (similar to the one shown in Fig. 101). which also serves for attaching the suspension rope. The hangers should be so formed that guard-rails can easily be secured to them, to protect the men from falling over the edge of the platform. The ladder is often strengthened by means of small wire ropes, about 5/16 of an inch in diameter, which extend along the under surfaces of the side-bars, from end to end.

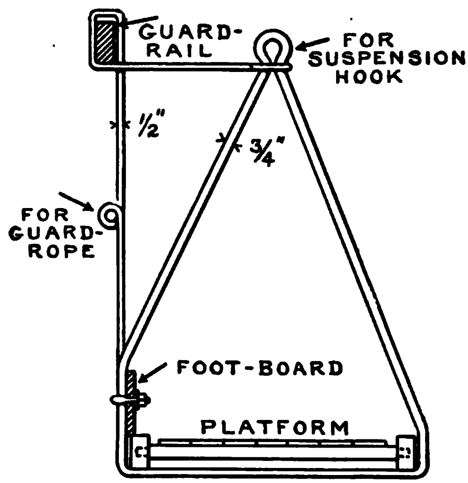

FIG. 101. AN APPROVED FORM OF PAINTERS' HANGER.
(The wheels or rollers are not shown. See Figs. 102, 103, and 104.)

The suspension ropes are arranged to run through blocks so that the men can easily raise or lower the staging, the hook of the lower block engaging in an eye or loop in the upper part of the hanger. The suspension rope is made fast to the point of the hook by means of a special hitch, which is shown in the accompanying



FIGS. 102, 103, AND 104. HITCH FOR SECURING A PAINTERS' SCAFFOLD.

(A loop, made in the suspension rope as shown in Fig. 102, is passed under the scaffold-iron and caught over the hook. The rope is then drawn snug, and carefully adjusted as shown in Fig. 103, so that the part that is under tension lies *below* the free end, and presses this end strongly and firmly up into the angle or V at the top of the scaffold-iron. The free end of the rope is finally drawn forward under the scaffold-iron, and caught loosely over the hook as in Fig. 104. The rollers mentioned on page 269 are shown in these cuts.)

illustrations (Figs. 102, 103, and 104). This hitch is exceedingly simple, and is secure when it is correctly made; but no person should undertake to use it in actual work until he has been carefully instructed by a man of experience.

There is a considerable amount of free rope to every "fall", especially when the staging is at the higher levels. This is usually allowed to lie upon the ground, but it is a much better practice to coil it up at the platform of the staging, because there is then no danger of interference with the scaffold by teams or by curious or meddlesome persons. Moreover, when the excess rope is left on the ground there is danger that it may become wet with acid that may be used for cleaning the walls of the building. Accidents from this source often happen, the acid soaking into the rope and ruining its inner fibers, so that the rope has no strength even though when superficially examined it looks to be in good condition. If the rope is secured to the platform, it is completely under the control of the workmen who are using the staging, and it is also out of the way of possible harm.

In view of the danger from acid rot, or from gradual weakening from simple exposure to the weather, the ropes that are used on painters' scaffolds should be thoroughly tested from time to time, to a stress that is materially in excess of any lcad that is likely to be thrown upon them in use. The full effects of acid do not develop for several weeks, as a rule, and ropes that may have been exposed to it should therefore be allowed to remain out of use for at least eight or ten weeks, before testing, in order to avoid the drawing of wrong conclusions from the test.

In addition to the tension test that is here advised for the ropes, the entire scaffold should be tested every time it is erected, and before any person is allowed to use it. For this purpose the platform should be raised a foot or so from the ground, and loaded with at least four times the maximum weight that it will be called upon to sustain in the subsequent work. (See paragraph 147.) If it shows no sign of weakness under this test, it may be considered to be safe to use.

When leaving a swinging scaffold of this kind, the men should always lower the platform to the ground, or lash it securely to the building, so that it cannot be blown about by the wind; and they should never leave buckets or other objects on it, that might become displaced and fall upon persons below.

The platform of the staging should be provided with wooden rollers or wheels some 6 inches or so in diameter, which will bear against the side of the building that is to be painted. (See Figs. 102, 103, and 104.) These hold the staging at a proper distance from the wall, and also make it easier to manipulate the platform when it is necessary to shift it to a new level.

The hooks that are used to support the scaffold, and which constitute the usual means of attaching it to the building, should be of generous size, and should be well made, and constructed of first-class material. Every time they are used they should be carefully examined for flaws or other similar imperfections, and further tested by ringing them on a stone sidewalk or in some other equivalent way. See that they are well anchored, and that the woodwork to which they are secured is sound and safe. Do not set them into decayed wood, nor into wood that is in any way open to criti-

cism with respect to its soundness or strength. If necessary, lay down a new plank and secure the hooks to this, nailing the plank in position whenever it appears to be desirable to do so.

On flat-topped buildings painters often use a form of hook or "cornice iron" consisting of a straight bar of steel bent at a sharp right angle near its middle point, and having an eye forged at the end of each arm. When an iron of this form is used it should be set so that its angle fits snugly over the edge of the cornice, with one arm extending downward and the other lying horizontally along the roof, at right angles to the edge. The eye at the end of the overhanging, vertical arm sustains one of the suspension ropes of the scaffold, while the eye at the end of the horizontal arm affords a means of making the iron fast to a chimney or other solid and substantial object on the roof. Cornice irons of this type afford an excellent support when they are applied as here described,—provided they are well made, from first-class stock of proper size; and provided, furthermore, the cornice is itself strong and secure. More commonly, however, the hook is made in the general shape of an interrogation mark, so that it may pass with a smooth, easy curve over the edge of the eaves or other projections, to the upper side of which it is secured.

When there is difficulty in attaching the hooks to the building, the scaffold is often supported by means of ropes that are passed over the peak of the roof, and brought down to the other side and made fast to some fixed object. This method of attachment is excellent, provided the ropes that extend over the roof are sufficient in size, and are known to be in good condition, and are securely fastened.

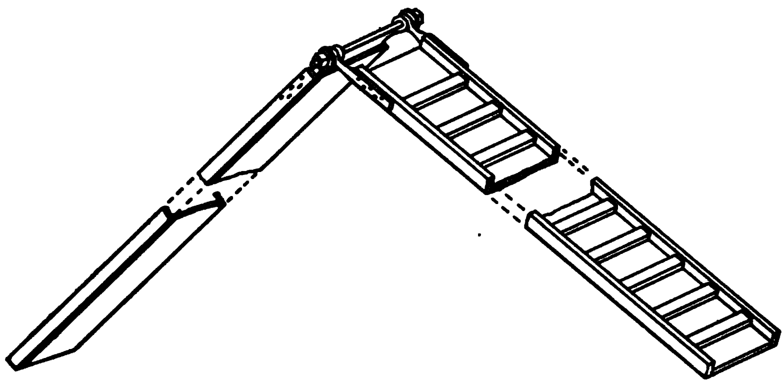

FIG. 105. DOUBLE CRAWLING-BOARD, OR "CHICKEN-LADDER."

(The two parts are alike, and are joined at the top by a hinge. The hinge bolt should be about one inch in diameter, and it may be removed to facilitate transportation or to allow either ladder to be used singly. Crawling-boards are also used in shingling, and in working on roofs of tile or slate. The side strips which are here shown may then be omitted, and the hinge may also be omitted if the boards are to be used singly,—provided they are effectively secured, as explained in paragraph 143. The whole construction may also be somewhat lighter, when the appliance is to serve merely to assist the workmen in passing from one part of the roof to another.)

Never work on a painters' staging with another man who is likely, for any reason, to do anything that might add to the natural hazards that cannot be separated from work of this kind.

In painting under the peak of a roof it is often convenient to secure the hooks to a special support consisting of two planks joined at their ends by a stout hinge, and laid over the roof so that the hinge comes exactly at the peak, with the planks lying in contact with both sides of the roof. (See Fig. 105.) Stout cleats, at least 1 1/4 inches high and two inches wide, should be securely nailed to the planks at intervals of a foot or so, and each hook should be set into one of the planks in such a position that it will be well supported by a cleat. Raised strips should also be nailed to the edges of the planks, to prevent the hooks from slipping off in case of any accidental shifting that may occur in

the course of the work; and the planks themselves should be tacked down to the roof for the same reason.

Two or more swinging scaffolds of the general type here described should never be combined into one by bridging the interval between them with planks.

In some localities the number of men that may work upon a swinging scaffold of this type is limited by law, and we strongly advise that the number be restricted to two, even though the local ordinance may allow more than this.

145. Needle-beam Scaffolds. A form of scaffold that is widely used in riveting up the steelwork of buildings, making light repairs, laying corrugated-iron roofs, and performing various other kinds of work in which the men frequently shift about from one place to another, consists of a plank platform resting upon two parallel horizontal beams (called "needle-beams"), which are supported at the ends by ropes. These scaffolds are not supposed to carry any considerable weight, but are merely for the support of men while they do light work that does not require the use of more than trifling quantities of material. When the needle-beams are not more than ten or twelve feet in length between supports, it is customary to make them four inches wide and six inches deep; but when the conditions are severe or unusual, this size must be increased in accordance with the length of the beams, and the weight that is to be supported. For example, in one case that recently came to our attention a scaffold of this kind was used for dressing the under surfaces of the arches of a concrete bridge, and as there was no way in which to support the needle-beams under the arches, they were made long enough to extend under the entire width of

the bridge. This made the span of each needle-beam about fifty feet, and for a beam of this length the cross-section mentioned above would be totally inadequate. The beams used in the case here cited were eight inches square, and were made of material that was first-class in all respects. Every needle-beam should in fact be made of straight-grained selected stock, and should be free from knots, shakes, and weaknesses of every other kind. (For an illustration of a needle-beam that did not fulfill these conditions, see Fig. 126.) Selected spruce may be used, or first-class long-leaf yellow pine. Spruce is much the lighter of the two, and it is preferable for that reason; but it must be of exceptionally good quality.

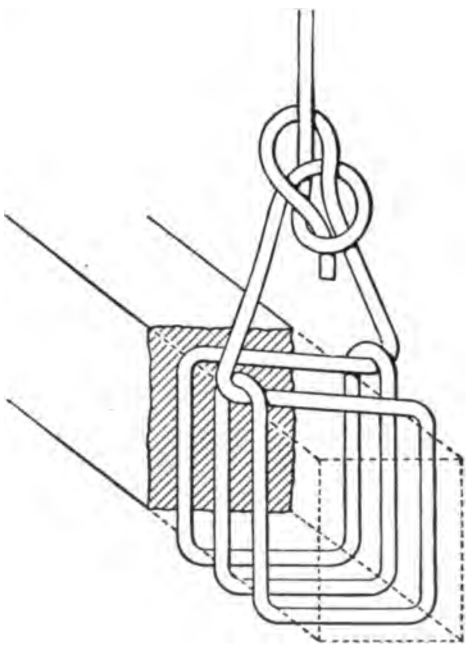

FIG. 106. ILLUSTRATING THE "SCAFFOLD HITCH."

In handling needle-beams, great care should be taken to avoid injuring them. They should never be dropped, but should be lowered with care so that they will not become broken, split, or seriously indented. It is easy to imagine the result of dropping a heavy 50-foot needle-beam from a considerable height, so that it falls centrally across a stone or a pile of lumber. It would almost certainly become damaged so that it could not be used with safety for a like purpose in another place.

The rope that is used for supporting the needle-beams should be first-class in quality, and should be made of pure manila fiber. It should be attached to each needle-beam by means of what is known as a "scaffold hitch", which is shown in Fig. 106, the loose end being finally tied to the main supporting rope by a bowline knot. The scaffold hitch should be arranged upon the needle-beam as shown in the illustration, and if it is applied properly it will prevent the needle-beam from rolling or becoming otherwise displaced. The size of the rope should be appropriate to the weight that is to be supported, including that of the workmen as well as that of the scaffold itself. In practice it usually ranges in diameter from one inch to an inch and a quarter; and it should never be attached to the needle-beam at a point less than one foot from the end of the beam.

As already noted, needle-beam scaffolds are often used for only a brief period in any one position, and for that reason they are commonly put up with very little regard for safety. This is a great mistake, because a man may be badly hurt by falling from a scaffold that is soon to be moved, just as readily as he can by falling from one that is to stand for a year; and the fore-

man in charge of the work should see to it, personally, that every one of these scaffolds is made safe before the men are allowed to use it.

Opinions differ, among safety experts who have given attention to the subject of scaffolding, as to the wisdom of erecting guard-rails on needle-beam scaffolds, and some maintain that the guard-rail may even constitute an additional hazard under certain circumstances. For example, when it is necessary for a man to swing a maul, an accident may be caused by the maul fouling the guard-rail. Furthermore, it is sometimes almost impossible to erect a guard-rail, owing to the place in which the scaffold is to be used; and it is a fair question whether or not it is wise to use guard-rails in some places and not in others, with the same type of scaffold and the same gang of men, because if they come to rely upon the guard-rail when it is used, this habit may cause them to fall at some time when it is not used. The best conclusion that we can draw with regard to this matter appears to be that the foreman should carefully consider each case on its own merits, and should erect the guard-rails or omit them, according to his best judgment, with due reference to the place where the scaffold is to be used and the nature of the work that is to be done upon it. Although we maintain that a rope railing is never as good as a railing of wood or metal, it is often better than no railing at all, and it can sometimes be used where a more substantial protection is out of the question.

As a rule, the plank floorings of these needle-beam scaffolds are much more serious sources of trouble than the guard-rails. The men are often permitted to work with altogether too few planks, or with planks that are

poor in quality, or of insufficient length. The foreman should always see that the flooring is safe in every respect.

In many applications of the needle-beam scaffold one of the beams stands higher than the other, so that the platform planks are set at a considerable inclination. Under circumstances of this kind there is often serious danger of the planks becoming displaced to such an extent as to fall from the needle-beams. In such a case the workmen may also fall, or the planks, in descending, may injure other persons who are below. This kind of an accident is particularly likely to occur when the men on the scaffold are using pneumatic "guns" or "jap hammers", the jar from which sometimes causes the planks to crawl into dangerous positions in the course of time, even though they may have been correctly placed at the outset. To guard against trouble of this kind it is best to bore a hole through *each end* of every scaffold plank, and to slip a long bolt through every hole. In order to prevent the bolt from dropping out in case the plank is turned over, it should be provided with a tightly-fitting nut, which should be screwed on far enough to avoid all danger of its working loose and becoming lost, but *not* too far to permit the bolt to act as an effective safety stop, whichever side of the plank is uppermost. The bolts should be placed *outside* of the needle-beams in all cases, so that the planks cannot slip off at the end. Some foremen who are quite willing to use these bolts at the *upper* ends of the planks object to using them at the lower ends also. The objection that is urged is that a bolt at the lower end is useless, because any shifting of the plank would take such a bolt further away from

the needle-beam, instead of bringing it up against it. It is wise, however, to use the bolts at both ends, because when they are used at only one end the workmen often lay the planks down with the bolt end at the lower needle-beam, and in this case the object of the device is totally defeated. It is therefore far safer to put a bolt at each end of each plank, as we have recommended.

When the planks are to be used in a steeply-inclined position, they should be provided with cleats to afford the workmen a good foothold, as described in the present paragraph or in paragraphs 143 and 144.

146. Plasterers' and Decorators' Inside Scaffolds. The scaffolds that are used for interior work by plasterers, painters, and decorators, and for making light inside repairs, are of very various kinds. When it is not necessary to reach high places, barrels are often used to support the planks upon which the men stand. These may serve the purpose, but they are not recommended because they frequently collapse while in use. It is particularly dangerous to stand on the head of a barrel, because it is likely to give way, causing the man standing on it to fall upon the ends of the staves, often with serious results, If a barrel must be used, a plank should be laid across it, from edge to edge, for the workman to stand on.

It is immeasurably better and safer to use horses or supports of other forms, upon which to lay the planks that constitute the working platform. Various special devices of this kind are shown in Fig. 107. All supports, whatever their nature, should be strong and sound. Trestles (or "horses") should not be used more than two tiers high, because if work must be

done at a greater elevation than can be reached in this way, it is better to substitute a support of some other kind. Special horses, much taller than the ordinary builders' horse, are often used when it is necessary to work on the ceilings or upper parts of rooms of ordinary height.

If it is necessary to increase the height of a horse somewhat, this should be accomplished by nailing on stout strips of strong, first-class material, and not by propping up the horse by means of bricks or other insecure objects, nor by using flimsy material that is unsuited to the purpose.

FIG. 107. LADDERS AND SCAFFOLDS FOR INTERIOR WORK.
(Exhibited at the Leipzig Architectural Exposition, 1913.)

When double ladders, hinged together at the top, are used for supporting platform planks, they should be designed so that they cannot be spread to more than a limited distance, and they should be opened out as widely as possible before the planks are laid on them. Short ladders of special form, leaning against walls, are often used to support planks for decorators' platforms. These frequently serve well enough, but they should never be used on slippery floors, nor should they be set, under any circumstances, at an angle sufficiently oblique to make slipping at the foot in the least degree likely; and ladders that are used in this way should preferably be provided with safety shoes or spurs.

English authorities recommend that the planks that are used as platforms in connection with ladders, steps, or folding trestles, should not be less than 9 inches wide and 1 1/2 inches thick, and that they should not have a span exceeding 9 feet, as measured between supports. The same authorities further recommend that steps shall not be used for supporting platforms that are more than 7 feet in height. These particular regulations have no binding force in the United States, unless they happen to be specified, here and there, in local ordinances; but they are nevertheless sound, and it is advisable to adopt them in our own practice.

When the work that is to be done is situated at a level that cannot be safely reached by such methods as we have described above, scaffolds are often erected that are similar in general design to the independent pole scaffold considered in Section IV (page 83) in connection with the building of walls from the outside. The poles and ledgers of a plasterers' or decorators' pole scaffold usually run in both directions, however, as

shown in Fig. 108, because the scaffold ordinarily occupies the entire room;—though when the room is of vast dimensions it may be left open in the center, an independent pole scaffold being built around the four walls, while the ceiling is reached from a suspended platform. For a particularly fine example of the last-named type of construction the reader may refer to the frontispiece of this volume, which shows one of the largest and most elaborate scaffolds ever erected for the use of decorators alone.

Fig. 109 gives an approved design, for ordinary heights, of a plasterers' pole scaffold of the type of construction shown in Fig. 108. When it is necessary to

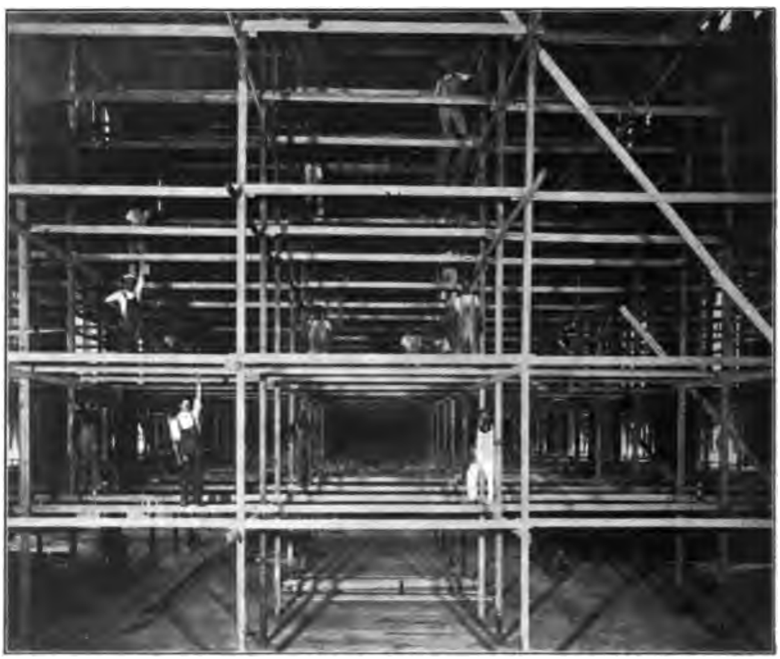

FIG. 108. INTERIOR POLE SCAFFOLD.

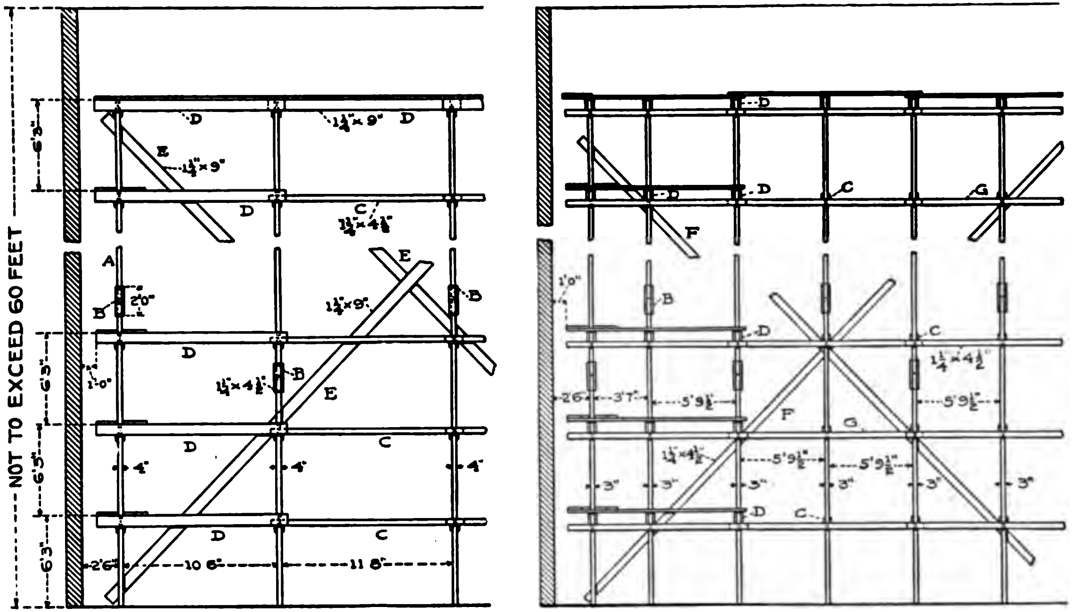

FIG. 109. DESIGN FOR A PLASTERERS' INSIDE SCAFFOLD.

(When the load is heavier than usual, or when the height, for an ordinary load, exceeds sixty feet, correspondingly larger stock should be used in the construction. All platform planks should be at least 1¼ inches thick, *by actual measurement.* Guard-rails and foot-boards are omitted from the engraving for the sake of greater clearness; but they should be provided on all working platforms except the topmost one, which is to be planked over completely. Compare Fig. 31, on page 92.)

extend the scaffold to an unusual height, the supporting poles should be made larger. The same general design may also be used for a painters' or decorators' scaffold, but the construction may then be somewhat lighter, because the weight to be supported is usually materially less.

Diagonal bracing, in both directions, is important in connection with interior scaffolds of this type, unless they stand practically in contact with the walls on all four sides. Even if they stand away from the walls somewhat (as they do in most cases), the necessary lateral support may be had, if desired, by thrusting out stringers or struts from the scaffold to the walls at every outside pole, and at every ledger-level. If this construction is objectionable on account of the danger of marring the walls, the ends of the projecting struts or thrust-outs may be padded. As a rule, however, it is important to keep them away from the building altogether, leaving a clear interval of at least a few inches in order to give the men free access to every part of the wall area; and in such cases reliance must be placed upon the diagonal bracing to stiffen the structure against vibration and deformation.

In splicing the poles of scaffolds of this kind the same methods are to be followed that are used in connection with the bricklayers' pole scaffold described in Section III (page 38). The same care should also be used in the selection of material, to have it both good in quality and ample in size and quantity. Care should also be taken to have the poles stand truly vertical, because the stresses that the diagonal braces may have to sustain will be materially reduced if this point receives proper attention.

Certain English authorities approve of spacing the platform planks of a scaffold of this kind so that between each pair of planks there may be an interval not exceeding seven inches in width (or some say one foot), when the scaffold is supported by poles and is constructed inside of the building. A similar spacing of the planks is also common in the United States, but it is far safer to plank the platforms over continuously and tightly wherever they are needed, and at other places the planks may be omitted entirely. When spaces amounting to from several inches to a foot are left between planks there is not much danger of workmen falling down through the openings, but there is always serious danger of tools and materials falling down and striking workmen below, and many accidents occur in this way.

147. Miscellaneous Scaffolds. Many of the scaffolds that are described in this book in connection with special kinds of work are also used with little or no modification for work of other kinds. The painters' swinging scaffold, for example, may be used for washing down a building, or for making light repairs. There are also many special forms of scaffolds, that are used for special purposes; but we cannot undertake to describe them all here, partly because a full description would take a prohibitive amount of space, and partly because the principles upon which their safety depends have already been sufficiently discussed in connection with scaffolds of other kinds.

In building or repairing factory chimneys, the work is done sometimes from the outside and sometimes from within, and sometimes from both sides simultaneously. In putting up a pole scaffold around the outside of a

chimney, careful attention should be paid to the bracing, because although the structure cannot well pull away from the chimney, it may nevertheless fall down by revolving or twisting around the middle line of the chimney as an axis, so that each pole falls in a sidewise or tangential direction. In repairing factory chimneys it is often necessary for a man to climb the chimney, either inside or outside. For this purpose it is best to have an iron ladder permanently secured to the chimney, both the ladder and its fastenings being so strong that there will be no danger of corrosion or other forms

FIG. 110. PORTABLE SCAFFOLD FOR LIGHT WORK.
(The platform is securely fastened to both trestles.)

of deterioration affecting them to such an extent as to make them dangerous to climb. When there is no such ladder, iron spikes may be driven into the chimney by the first workman as he climbs up. No man should be permitted to undertake a task of this kind unless he has had great experience in working at high altitudes, and has demonstrated his fitness for it; and the man who does the work should be required to attach himself securely, by the aid of a stout life line, to each spike before he undertakes to drive the next one above.

Protection should be provided inside of chimneys as well as outside, when the men are to work within the shaft, to guard against the fall of tools and materials from upper levels upon persons working below. Platforms are often supported inside of chimneys by merely resting them upon offsets of the brick-work within the shaft. We do not consider this to be good practice unless the offsets are unusually wide, and even in that case the platforms should be arranged with special care, so that it will be impossible for any of the planks to slip away from the supporting ledges and fall down.

Iron stacks, which have to be painted at suitable intervals, should have solid iron ladders permanently attached to them, as already described in connection with chimneys. When such ladders are provided, every man who has to climb them should be furnished with a safety belt, attached to a strong hook which the climber can catch over the rungs of the ladder as he proceeds upward.

When an iron stack has no ladder, it is often provided with a pulley at the top, over which a rope runs,

after the manner of the halliards on a flagpole. By means of this rope a steel cable with a securely-attached hook can be drawn up, so that the hook can be made fast to the top edge of the stack. When this method is used, no workman should be allowed to trust his weight upon the halliards that have been exposed to the weather. These should be used merely for drawing up the cable by means of which the man who is to install the scaffold is to be raised.

For cleaning buildings, "cradles" are often used, similar to the painters' swinging scaffold. These should be of sufficient size for the use to which they are to be put, and they should be strongly made, and provided with stout suspension ropes and with a guard-rail and foot-board all around.

Whenever scaffolds suspended by ropes are used, whether on chimneys or on any other kind of structure,

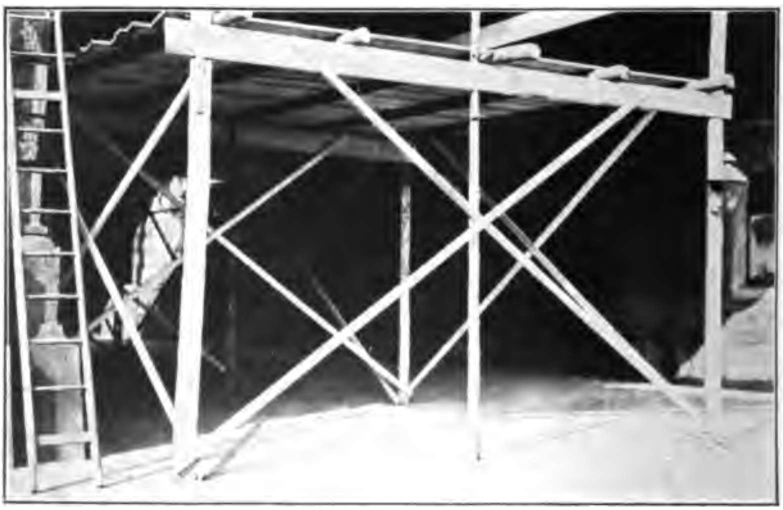

FIG. 111. FIXED POLE SCAFFOLD FOR LIGHT WORK.
(Note the bracing, in both directions.)

they should be carefully tested (as described in paragraph 144 in connection with the painters' scaffold) by raising them a foot or two above the ground, and then loading them with a weight that will bring upon each rope a load at least four or five times as great as any stress to which it is likely to be subjected during the progress of the work for which the scaffold is to be used. It is often recommended that scaffolds be tested in this way to *twice* the load they are to carry, but we do not consider it sufficient to demonstrate in this way that a scaffold has a factor of safety of *two*, under a dead load. A moving load, such as may be caused by a sudden change in the position of the men or by the fall of one or more of them upon the scaffold platform, might easily strain the suspending ropes to twice the stress to which they are normally subjected by the equivalent dead weight; and hence we feel that a factor of at least four or five should be employed in applying the test load.

Roofers' scaffolds, for use in laying roofing of corrugated iron or other similar material, should have platforms approximately parallel to the slope of the roof, and hung at a convenient distance below the roof by means of wire-rope slings. These scaffolds should not be used for supporting any weight except that of the men themselves. The platforms should be provided with heavy cleats spaced at intervals of not more than 10 inches or one foot, and the planks should be secured in some very positive way, so that they cannot slip off of the bearer-bars (or "needle-beams") on which they rest and by which they are supported. (For further suggestions applicable to scaffolds of this kind, the reader should refer to page 272, paragraph 145.) It

FIG. 112. A BOATSWAIN'S CHAIR.
(Courtesy of Illinois Steel Company.)

FIG. 113. ANOTHER FORM OF BOATSWAIN'S CHAIR.
(Note the stirrups, and the knots in the suspension rope.)

would be well to have catch-nets suspended by some independent means below the needle-beam scaffolds used by roofers, to prevent the men from falling to the ground in case of accident; but this would be so marked an innovation that it is doubtful if we can hope for any widespread adoption of the idea in the near future.

The "boatswain's chair" can hardly be called a scaffold, but it may be mentioned appropriately in this place because it is widely used for painting and cleaning, and for other small operations which can be performed by one man, and in which no considerable

amount of material has to be handled. It consists of a seat, attached by means of a sling to a suspension rope. The suspension rope sometimes passes through a block overhead, as in Fig. 112, and it is sometimes made fast to a fixed object above, as in Fig. 113. It may also be secured to a pole by means of a suitable hitch just above the chair, as in Fig. 114. The last-mentioned method is often used in painting flagpoles and other similar objects, when no adequate provision has been made for hoisting the workman by other means; but it is not recommended if either of the other two methods can be safely applied. When the chair is suspended by means of a rope passing through an overhead block, it is safest to have the free end of the rope secured to some fixed and easily accessible object, and to have the chair raised and lowered by two or more helpers. If this is not practicable, however, the workman in the chair may do the raising and lowering himself, if a safe and suitable method of fastening the free end of the rope has been provided at the chair. When the suspension rope is attached to a fixed point overhead as in Fig. 113, or is secured to a pole by means of a hitch as in Fig. 114, it is important to provide the workman with stirrups upon which he can rest his weight while he is shifting the hitch by which the chair is made fast. In any such case the stirrups must be supported independently, and with the same care as the chair itself. Whenever practicable, the tools and materials required by the workman using the chair should be delivered to him in a bucket or basket by a helper, as shown in Fig. 113. In every case, too, the man in the chair should wear a strong safety belt, secured to the supporting tackle in such a way that he

FIG. 114. A BOATSWAIN'S CHAIR ON A FLAGSTAFF.

(Note the independent stirrup, on which the workman rests his weight while shifting the position of the chair.)

will be safe even if he should fall from the chair. The suspension rope should be first-class in quality, and should be tested, before use, with a load at least four times as great as it will have to sustain while in service. It should also be carefully protected against exposure to acid, or to heat that might conceivably char or otherwise damage it, or to any other recognized cause of deterioration.

XII. STRUCTURES SIMILAR TO SCAFFOLDS.

148. Sidewalk Protection. In putting up a building fronting on a city sidewalk it is highly important to provide proper protection to pedestrians and others who have to use the sidewalk or street. For this reason it is necessary to build over the sidewalk a protective structure that will be strong enough to prevent accident from any material that may fall. This structure is sometimes called a "sidewalk shed" and sometimes a "sidewalk bridge." The former name is preferable, because it refers to the protective value of the structure. The name "bridge" is given in reference to the fact that in construction work it is often necessary to temporarily remove the sidewalk, or some part of it, and it then becomes important to bridge over the gaps that are left, in order that travel may not be interrupted. The sidewalk shed, as usually constructed, serves both of these purposes, because it is both a shed and a bridge.

The design of the shed will naturally depend largely upon the conditions to be met. It sometimes happens that if no material of considerable weight is to be handled, a shed of light construction is sufficient; but in case it is necessary to deal with heavy materials, such as beams and blocks of stone, the shed should be of exceedingly stout construction.

The accompanying diagram (Fig. 115), which represents a shed that was used during the erection of the

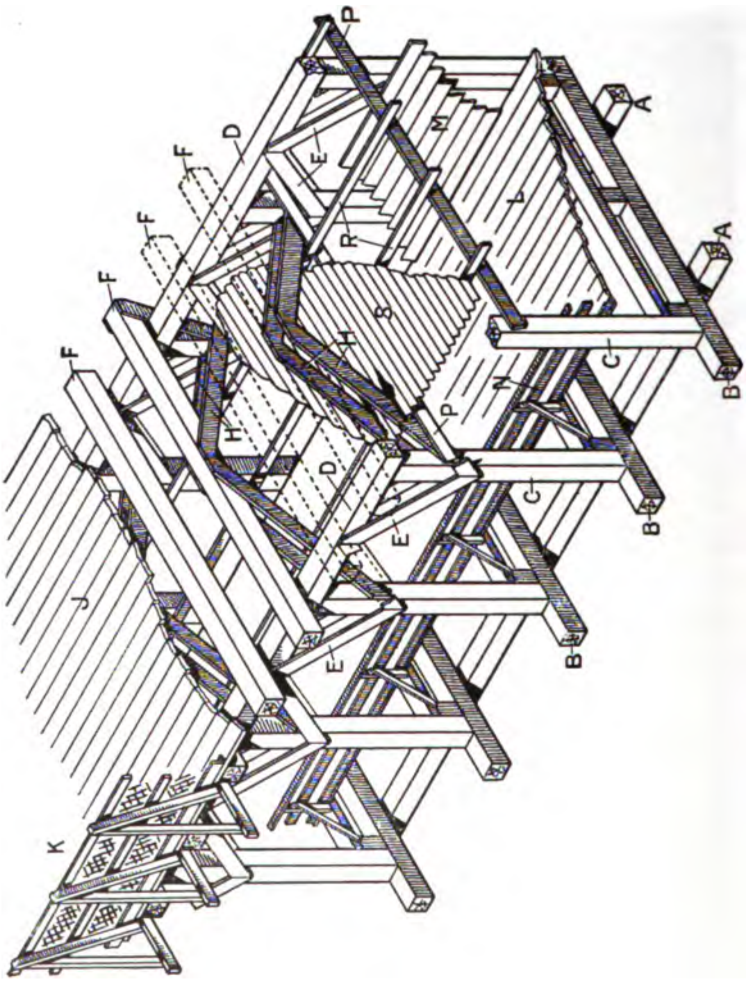

FIG. 115. A WELL-DESIGNED SIDEWALK SHED.

Home Office building of The Travelers Insurance Company, shows a good general form of construction that is recommended when heavy work has to be handled. No attempt is here made to show the bridge structure by which the shed was supported from below, as it was thought best to fix attention on the part of the shed relating to the protection of the sidewalk.

The shed rested upon two stout sills, *AA*, which were supported by the bridgework to which we have referred. Across these sills lay others, *BB*, spaced at intervals of about eight feet, and upon these rested the vertical posts *CC*. Running over the tops of these posts, and resting upon them, were other horizontal sills *DD*, which in turn supported heavy cross stringers, *FF*, which were of the same size as the lower stringers, *BB*, but twice as numerous.

To stiffen the structure in a lengthwise direction, diagonal braces were erected, as shown at *EE*, and to give it similar support for resisting deformation or displacement sidewise, similar diagonal braces, *HH*, were provided.

Over the stringers, *FF*, there was laid a flat, horizontal roof, *J*. composed of stout spruce planks laid closely together. At the street margin of this plank flooring a strong high framework, *K*, was erected and made fast to the stringers, *FF*. This frame was covered with strong, close-meshed wire netting.

The shed was provided with a plank flooring, *L*, which was protected on the street side by a stout guard-railing, *N*, provided with a foot-board and strongly braced as shown. At the inner side of the shed, toward the building, a high plank partition, *M*, was erected to protect passers from exposure to hazard of any kind.

The planks composing this partition were also set close together, and rested in contact with the floor planks, L.

For the protection of passers against rain and melting snow, a corrugated-iron roof, S, was provided. This was set at a proper inclination to shed water freely, and was located immediately below the cross-beams FF. It was supported upon the longitudinal stringers shown at R, which were themselves supported by inclined cross-pieces, PP.

Sidewalk sheds are often used for the storage of materials, and to a certain extent this is necessary; but extreme care should be taken to see that they are not loaded beyond their safe capacity, after making allowance for a large factor of safety. The man in

FIG. 116. ORNAMENTAL SIDEWALK SHED IN NEW YORK CITY.

FIG. 117. A VERY ARTISTIC SIDEWALK SHED.

charge of the work should see to this personally, because if he does not do so the workmen are likely to go on depositing more material on the roof of the shed after it is already loaded to its safe limit, since it is a convenient place for such storage.

Another point to which attention should be called in this place is the location of the contractor's office. This is usually placed somewhere on the roof of the bridge, and for some incomprehensible reason, or perhaps for no reason at all, it is commonly located in an unnecessarily dangerous position. Whenever there is a choice of location, this office should be placed where it will be least exposed to accident from falling material.

FIG. 118. AN EXCEEDINGLY ORNATE SIDEWALK SHED.

In recent years there has been a movement in favor of making sidewalk sheds more or less ornamental, and in a few of our larger cities local municipal art societies have interested themselves in this movement in the belief that there is no reason why a bridge of ugly appearance should be erected on a public street, if the contractor is willing to provide one of more seemly appearance. Figs. 116, 117, and 118 show bridges in which an attempt at ornamentation has been successfully carried out. Attention is particularly directed to the bridge shown in Fig. 118, which is ornamented, as will be seen, with flowering plants and also with shrubs set in tubs. The ornamentation of sidewalk sheds is commendable, but it should never be overlooked that the strength and safety of the shed should always be the first consideration, and no thought should be given to ornamentation of any kind until safety has been absolutely assured.

149. Catch-scaffolds and Platforms. We have already referred, in paragraph 75, to the importance of providing protection over passageways and workplaces, to prevent workmen and other persons from being injured by the fall of material from scaffolds above. When the scaffolds are high the importance of protection is very much greater, and the protection in such cases should be correspondingly more complete. It should also be arranged with reference, not only to the passages and workplaces that may be below, but also to sidewalks, streets, and the ground level in general. Sometimes sufficient protection may be had by means of a thrust-out scaffold that is confined to some particular part of the building, where the hazard is greatest. Catch-scaffolds of this kind are shown in Fig. 119.

FIG. 119. SHOWING CATCH-SCAFFOLDS FOR PROTECTING THE SIDEWALKS AND STREETS FROM FALLING OBJECTS.

High up on the building in the foreground two such scaffolds may be seen, and in the rear another is shown that extends along the entire side of the building. It is important in platforms of this kind to provide the outer edge with a stout board fence, or with a strong screen of close-meshed wire netting.

In the erection of the Woolworth Building in New York City special attention was given to the construction of catch-scaffolds of this kind, and platforms 20 feet wide were thrust out from the building at four different heights. These had wire-mesh screens arranged along their outer edges to give still further protection. Fig. 120 shows three of these platforms, and Fig. 121 shows the appearance of the platform at the fifteenth floor, which is the lowest one of those shown in Fig. 120. The amount of debris on the floor of this platform should be especially noted. Some of the fragments would have produced very serious injuries if they had struck persons below.

The wire netting at the edge is not supposed to be relied upon for checking the direct fall of materials, but after they have struck the main platform they often rebound somewhat, and the netting is useful in preventing such fragments from bounding or rolling over the edge of the platform.

We have referred, in paragraph 143, to the advisability of having platforms for preventing the fall of men who are engaged in work upon steep roofs, and the counsel that is there given will of course apply with such modifications as may be necessary to other conditions where similar hazards prevail.

It has often been urged that in the case of a pole scaffold a fully planked platform should be left a short

distance below the one on which the men are working, so that in the event of failure of the upper platform the men would fall only a short distance. Authorities

FIG. 120. CATCH-SCAFFOLDS ON THE WOOLWORTH BUILDING.

who have given attention to the subject of safety in connection with building construction are divided among themselves with regard to the advisability of

FIG. 121. SHOWING ONE OF THE PLATFORMS OF FIG. 120.

adopting this plan. There can be no doubt that it is a wise precaution if the builder is willing to go to the expense that is involved (which may often be confined to the furnishing of extra platform planks and the doing of a little more work), and if the extra platform is also put up in such a way that it does not interfere with the proper bracing and staying of the scaffold as a whole. In scaffolds of the independent pole type (such as are discussed in Section IV, page 83) a number of platforms are often necessary, either for the storage of material in reasonable amounts, or for the carrying on of the work; and in such cases the auxiliary platforms that are required for these reasons, serve also as catch-platforms to check the fall of the men in the event of failure of the topmost platform.

150. Material Hoists. In the present section we shall refer merely to the construction of these hoists, and shall not discuss the operation of them. There are many important questions relating to signals, guarding, and other matters, to which it is important to give careful attention in order to insure safety; but these are too far removed from the general subject of scaffolds to be appropriately treated in this volume.

Hoists that are built inside the building, and constructed and operated similarly to ordinary freight or passenger elevators, call for no special mention here. It is only when they are built in the form of separate structures (usually external to the building), that they are appropriate subjects for consideration in a book that is confined to scaffolding and closely allied structures. When so built, the hoists usually take the form of towers, and they must be constructed so that they will have the necessary strength and stiffness to sustain

FIG. 122. A PAIR OF MATERIAL HOISTS.

all the various stresses to which they may be subjected. Such towers should be built of sound material, and should be designed and erected with careful regard to the maximum loads they may have to carry. They should be strongly cross-braced and strutted, and should have exceedingly firm and solid foundations. Great care should also be taken to see that they are made secure against overturning in any direction. With this in view, they should be safely guyed, or strongly anchored to the building itself, or fixed solidly in some other effective way. When used in connection with a high building, they should not be run up to their ultimate height at the outset, because if this is done the problem of keeping them safely in position is often serious, until the framework of the building has risen to a considerable elevation. In such cases it is better to limit the hoist-towers, at first, to an altitude that will suffice for immediate needs, and to extend them upward when the work has proceeded far enough to make it feasible to provide a safe support by bracing their lower parts to the framework of the building. Care should be taken to have all towers of this kind truly straight and vertical, so that the uprights that sustain the loads will not be exposed to bending stresses, and so that the guys or other supports that are provided will not be subjected to stresses of unnecessary severity. In Fig. 122, which shows a pair of material hoists of the kind here under consideration, it will be particularly noticed that the two towers are fastened together in several places, both by horizontal stringers and by diagonal braces. They are also secured to the building at three different heights, by beams that pass in through the window openings in such a manner that

they will not interfere with the progress of the work.

Hoistways of this kind are often sheathed with boards, and where this is done it is best to cover them on the *inside*, because a smoother surface is thereby presented to the moving material, and loads are less likely to catch against projections in the shaftways. Long pieces of material, when placed endwise on the cage or platform of a hoist, sometimes give serious trouble in this way; and boxes and other objects that are placed too near the edge of the platform often become displaced so that they catch on the framework of the hoistway. The method of sheathing here recommended is seldom followed in practice, the sheathing being usually put on the *outside* of the framework. There is apparently no good reason for doing this, however, except that the hoistway looks a little better from the outside, and that it is somewhat easier to handle the sheathing in putting it on. Aside from the small amount of extra work that may be required in the construction, the only objection that can be offered against placing the sheathing on the inside as we recommend, is that by so doing it becomes necessary to have the hoistway two or three inches larger, each way.

Some forms of scaffold-like structures that are used in connection with hoisting have elevated platforms upon which men must stand or work. All platforms of this kind should be ample in size, and they should be closely planked over, and provided with guard-rails, foot-boards, and netting, as described in paragraph 130 in connection with suspended scaffolds for construction work. Safe means of access to these platforms should also be provided. Stairways are greatly to be preferred for this purpose, although runways or ladders

may also be satisfactory if they are properly constructed, guarded, and secured.

Fig. 123 shows a form of hoisting scaffold that is used to a considerable extent in Germany, especially in

FIG. 123. A GERMAN MATERIAL HOIST.

connection with the erection of stone buildings. The wall that was being laid in this particular case was parallel with the street, and located just back of the sidewalk shed. It cannot be seen in the engraving, except in one small section just above the level of the top of the shed at the extreme left. The framework was thoroughly braced in both directions, and the braces and other parts were fastened together by bolts of generous size. Along each side of the structure, at the top, there was a platform with a hand-rail and foot-board, and a track was also provided, along which a hoisting machine traveled so that it could be used at any point to raise a stone to its proper position upon the wall. A hoist of this kind, in its construction and operation, closely resembles a temporary traveling crane.

Other crane-like forms of hoists are used in connection with the raising of material for building operations, but we shall not discuss them in this work because they can hardly be included under the general heading of scaffolds.

Whatever the method that is used for raising the materials, all persons should keep from under loads that are being hoisted, or that are suspended in the air; and stones, bricks, tools, and other materials should always be handled by safe methods. Small objects may be placed in buckets or other similar receptacles, and when slings are used they should be employed only in connection with objects for the handling of which they are adapted.

151. Arch Centers and Other False Work. All work of this kind should be erected and supervised under the direction of a designated man who thoroughly understands the subject and its dangers. The false

centers that are used in the construction of arches should be made particularly strong, because they are often loaded very heavily. They should also be solidly supported from below, so that they cannot sink under the weight to which they are subjected, and they should be effectively braced or shored so that they cannot fall over sidewise. False centers should be held in position by wedges or in some other equivalent way, so that they can be removed without straining the structure that

FIG. 124. FALSE WORK FOR SUPPORTING A STONE ARCH.

they have supported, and without communicating shocks to it,—the wedges being carefully backed out before the centers are otherwise disturbed.

Arch centers should never be removed until the cement, mortar, or concrete is thoroughly set, nor until the abutments are heavy enough and strong enough to withstand the thrust of the arch with entire safety.

XIII. GENERAL COUNSEL.

152. Introductory. The present section, being devoted to counsel with regard to scaffolds in general, is to a certain extent a review of those parts of the preceding sections that relate to the management of scaffolds and of the workmen who build them and use them. More or less repetition of matter that has already been given in earlier parts of the book is therefore inevitable. The section is far more than a mere review, however, because it also contains many suggestions that were omitted from earlier pages, or that were passed over with little more than a bare mention.

153. Construction and Material. One of the most important duties of a contractor or other employer, in connection with the erection of a scaffold, is to see that the work is done under the immediate personal supervision of a man who thoroughly understands the dangers that are involved, and who knows what precautions should be taken to insure safety. It is just as necessary to employ experienced and careful men in building scaffolds as in building more permanent structures; but any observant person, by merely looking with critical eye at the various scaffolds that he passes in his daily life, can see that a large proportion of them are built by men who have no special training or fitness for the work, and who are either unaware of the dangers to which the work-

men are exposed, or unwilling to take a little more time and trouble in order to eliminate these dangers.

An English committee that gave considerable attention to scaffold hazards a few years ago made the following suggestion, in which we heartily concur: "It would be a great boon to all concerned if some means were devised to educate workmen in the skilful construction of scaffolding, and the attention of authorities engaged upon technical education might (profitably) be drawn to the desirability of offering evening-school instruction in regard to this, with practical demonstrations". The instruction should not be confined to evening schools, however. In our opinion it should be given in all institutions devoted to technical education.

One of the commonest errors in scaffold construction consists in using inferior material, and using it in insufficient amount. Nothing but the best and strongest material should be employed, and it should be provided, and used, in generous quantities. The man who is in charge of the erection of the scaffold should be held strictly responsible for any shortcomings in either respect, and he should remember that although economy of material is commendable in most places, it should be the very last consideration when putting up a scaffold.

Spruce is strongly recommended for most of the wooden parts of scaffolds, though long-leaf yellow pine is also satisfactory when it is of really first-class quality.

Scaffold practice in the United States differs from that in other countries in many respects. For example, the suspended scaffolds that are described in Section X (page 168), and which are used so generally in the

construction of high buildings in this country and in Canada, are almost unknown elsewhere. There are many minor differences in practice, also. In England, for example, the putlogs of bricklayers' pole scaffolds are supposed to be securely fastened in place, whereas in the United States it is customary to rely upon the weight of the platform and its load to keep the putlogs from shifting their positions, and there are few accidents that can be attributed to our omission of the fastenings, when the scaffold is built in accordance with the standards advocated in this book, inspected at proper intervals by competent men, and thoroughly protected against accidental shocks and other disturbances. When a putlog is first laid, in the bricklayers' pole scaffold, the wall where it rests is "green";—that is, the mortar is still soft. Hence the adjoining bricks would be likely to be displaced by driving wedges for the purpose of securing the putlog in its hole, and the wedges would not hold well. Moreover, a pull on the putlog that would be sufficient to overcome the friction between the putlog and the wall would be likely, when the wall is "green", to pull one or more bricks away with it if wedges were used, and therefore little or nothing would be gained. It is safest to pay careful attention to the bracing by which the scaffold is tied to the building, distributing this well and making it amply strong, so that endwise stresses on the putlogs may be wholly avoided.

Nothing should be done hurriedly in erecting a scaffold, and makeshifts, either in materials or in methods, should never be adopted or permitted. Everything about the job should be done in the safest way possible, and all superintendents and foremen

should be specially and definitely instructed to take every precaution that appears to be needful for the prevention of accidents.

In using suspended scaffolds of the overhead type (see page 194) it is wise to have a man watch the machines, to prevent the cables from "riding", as described in paragraph 116. When this tendency is first observed it can often be effectively checked by pushing the cable into its proper position by means of a stout stick.

The attention of a man engaged in erecting a scaffold should never be drawn away from his work, even momentarily. There may appear to be no harm in consulting him upon some other matter, or in obtaining his assistance, temporarily, on some other job; but if he is disturbed in this way he is likely to forget some important thing, and leave some part of the scaffold in an unfinished and dangerous state.

154. The Human Element. Every person who wishes to make use of a scaffold should be required to satisfy himself of its safety, before venturing upon it. This condition should be strictly enforced with respect to every individual workman, and no workman who is not so satisfied should be required to use the scaffold, nor should he be penalized in any way on account of his refusal.

Foremen should assure themselves that there is no ill feeling among men who have to work together under conditions in which friendly co-operation is essential to safety. This counsel applies not only to individual workmen, but also, and perhaps with greater cogency, to cases in which two or more gangs of men, engaged upon different parts of the job, have

to work together. Instances could be cited in which feeling has run so high, between gangs of men working on the same job but having different interests at stake, that open hostilities have broken out, high up on the framework or scaffolding of a building, with very serious results.

Workmen who suffer from nervous ailments, or who are subject to dizziness or to attacks of faintness, or who are partially deaf, or near-sighted in any important degree, or who suffer from rheumatism or any other affliction that might impair their activity of mind or body, should give notice of the fact to the foreman, before beginning work; and such men should never be assigned to difficult duties, nor to any kind of work the natural and inevitable hazard of which would be materially increased by reason of their maladies or imperfections.

Youthful and inexperienced persons, even though well and strong, should never be assigned to work requiring skill and sound judgment. In dealing with foreigners, see that they clearly understand the orders they receive, and the dangers to which they are exposed.

The safety spirit should be instilled into the minds of the men in every way possible. They should be made to understand that their own safety is desired above all else, and that precautionary measures that are taken by the employer or the foremen must necessarily fail to be wholly effective unless the men are willing to co-operate in all possible ways. Every man should be encouraged to report any defect he may discover, and to make any reasonable suggestion that may occur to him for securing greater safety.

Wrestling, scuffling, "horse-play", or the playing of so-called practical jokes, should never be permitted about a scaffold nor about any part of a building in course of construction; and no workman should be allowed to climb or slide upon ropes, chains, or poles, nor to ride on loads, nor upon material hoists of any kind. There should be no unnecessary shouting or other loud or disturbing noises in the vicinity of the scaffold. See that everything is done in a dignified, seemly way, so that the workmen may be in complete possession of all their faculties, at all times.

Never allow a workman to expose himself to unnecessary danger, nor to cause any of his fellow workmen to be exposed to such danger. Men sometimes expose themselves purposely in this way, apparently to impress their associates with their coolness and indifference. This tendency should be firmly repressed. The unavoidable hazards are quite large enough, and there is no need of wilfully increasing them.

Nothing should be thrown down from a scaffold without the express permission of the foreman, who must never give such permission without taking every necessary precaution to see that nobody is exposed to danger. (Compare paragraph 159.)

Do not let the men throw things down upon the scaffold platform, and do not let the men themselves jump down upon the platform from a higher level. (See paragraph 127.)

Men who work upon scaffolds or in other elevated places should avoid the use of alcoholic drinks of any kind, during working hours or before them. Intoxicated men should never be permitted to work upon a

scaffold, nor even to loiter about the workplace. This rule should be enforced not only against men who are uncertain in their movements or disposed to give trouble, but also against all who show signs of intoxication even in the slightest degree. The handling of cases of this kind is often a delicate matter, but the foreman should be firm and should make it plain that his action is prompted solely by his interest in the safety of the men, and not by any desire to give offense.

155. Inspection and Supervision. No scaffold should be used by the workmen, nor should any material be lodged upon it, until all the work of construction has been completed, including the installation of the bracing and the erection of the hand-rails, foot-boards, and other protective devices. The temptation to work upon an unfinished scaffold is often very considerable, owing to the work being in a backward state, or to the offering of a large bonus for haste, or to the need of closing in the walls during the continuance of favorable weather, or for some other strong reason. It should never be done, however, because the disadvantages are likely to greatly outweigh the supposed advantages.

Every scaffold should be carefully inspected by a competent man, after it is completed and before it is used. This is essential even when the scaffold is of relatively small importance and is to be used for a very brief time, because structures of this kind, that are to be used only for a few hours or a few days, are particularly likely to be erected without due regard to safety. Fig. 125 illustrates this fact. The plank there shown was laid down to stand on, while doing some work on the iron stack; but instead of providing a

proper support for it, the workman propped up one end by means of a shaky combination of two tiles and an inverted mortar box.

A far more striking example of carelessness and indifference is illustrated in Fig. 126, which shows a riveters' scaffold that was erected for use in the construction of a modern steel-framed building. These scaffolds are used for only a short time, and they are often put up with correspondingly little care. In this

FIG. 125. AN EXAMPLE OF CARELESSNESS.

case the wooden piece that was used for the needle-beam, and which is indicated at A, was not long enough to serve its purpose properly, and it was therefore pieced out by the steel-workers in a peculiar manner, by means of a couple of blocks of wood of the same thickness as the needle-beam, and a pair of thin, weak side-strips to hold them in place, as is plainly shown in the illustration. This construction would be hazardous enough, even if the material were sound; but to make the case worse the side-piece

FIG. 126. A DANGEROUS NEEDLE-BEAM SCAFFOLD.

(Erected for use by a gang of riveters on a large office building. Note the weak section at *B*. This condition was discovered by a TRAVELERS inspector, who reported it to the superintendent of the job and had the structure condemned before the riveters could use it.)

facing the observer had a very bad knot in it directly opposite the point B. It may be of interest to state that this construction was detected by a TRAVELERS inspector very soon after the scaffold was placed in position, and was promptly condemned before it could cause an accident.

Examples of carelessness similar to those shown above are to be seen everywhere on construction jobs, and they contribute greatly to the accidents that occur in connection with such work. They are also common in many other places.

It should be the duty of some specified person to keep a general watch over every scaffold, large or small, during the entire period that it is in use. The man to whom this duty is assigned should be constantly on the watch for thoughtless and careless work such as we have described above, and he should also inspect every scaffold thoroughly at least once a day, to see that it is constantly maintained in a good, safe condition. The best time to make the inspection is in the morning, before the men are at work. The supervision should be particularly careful and searching when the conditions are such that the failure of the structure would be likely to endanger a considerable number of persons, whether they are workmen or not. The inspector should examine the various fastenings to see that they have not become loosened, and he should also give close attention to the supports, braces, suspension cables, ropes, clamps, putlogs, bearer-bars, platform planks, guard-rails, ladders, and all other parts that are essential to strength and safety; and when inspecting a bricklayers' pole scaffold he should be particularly careful to see that the putlogs

rest in the proper manner in the holes provided for them in the wall.

It is an excellent plan to have a special inspection of every large scaffold made once a week, in addition to the daily inspections here recommended. After every special inspection of this kind, a written and signed report should be submitted to the superintendent, in which a definite statement is made with regard to the condition of every important element of the scaffold.

Work upon scaffolds should be discontinued during severe storms and high winds, and after every such storm or wind the scaffolds should be thoroughly inspected in every detail, and any damage that has been done should promptly be made good. In making an inspection after a storm it should be remembered that planks and other wooden parts swell when they become wet, and care should be taken to see that no damage has been done to the scaffold from this cause.

In wintry weather scaffold planks, ladders, runways, and other surfaces where men must step or loads must be deposited, often glaze over with ice or frost so as to become exceedingly slippery. All such surfaces should be liberally sprinkled with sand or ashes or some equivalent material, before the men are allowed to use them. The upper surfaces of walls upon which beams and other heavy objects are to rest temporarily should also be treated in the same way.

The great importance of overhead protection, and of guard-rails, foot-boards, and side screens, is evident from the fact that in a large proportion of cases the accidents that occur are due either to the falling of the men themselves, or to the fall of tools or materials upon men who are working or passing

below. Special attention should be paid to safeguards of this kind, and they should be kept in first-class condition at all times.

Many accidents occur from the fall of hammers and other implements that are carried loosely in the belts or pockets of workmen. The men should not be allowed to carry tools in this way when climbing ladders, or when working on sloping roofs or in other high places with no protection but safety-belts and life-lines.

Runways should preferably consist of an odd number of planks, so that a wheelbarrow will "track" along the middle of a plank, and not along the crack separating the abutting edges of two contiguous ones.

On platforms and similar places, boards having a thickness of 1 1/2 inches or less should not project over the beams, putlogs, bearer-bars, brackets, or other objects that support them, by more than 6 inches; and planks having a thickness of 2 inches or more, when used in like manner, should not project beyond their supports by more than 12 inches. This is on the assumption that the boards or planks are not fastened in any way. A materially greater projection may of course be allowed if they are made secure against tipping, by nails or otherwise.

Take special care with ladders, because they cause a great many accidents. (See paragraph 76.) The rungs should not be loose enough to roll, and ladders with missing rungs should not be used. See that the side-bars rest evenly and securely on a firm and level foundation, and never block them up with bricks, tiles, or other similar objects.

See that all hammers, saws, axes, chisels, and other implements are kept in safe places.

Look carefully for projecting nails and sharp splinters, and see that they are removed at once, or made harmless. (See paragraph 159.)

Scaffolds and their approaches, particularly in connection with construction work, are often used for the storage of tools and materials. This cannot be wholly avoided, in all cases, but it is often done to an unreasonable extent. Passageways and stairways are frequently used in a similar way, with the result that they become littered up so that they are dangerous to the workmen. See that obstructions of this kind are reduced to a minimum, and do away with them altogether whenever possible.

On scaffold platforms take special care of barrels and all other objects that may tip over or roll.

See that bottles containing gasoline, muriatic acid, or other chemicals are plainly marked, and put them in charge of some one responsible man. Pails that are used for acid solutions or other poisonous substances should be plainly marked "POISON", and should never be used for any purpose other than the one for which they were intended. In particular, they should never be left about where they may be mistaken by the workmen for buckets of drinking water.

Great care should be taken in handling keystones, window capstones, and other similar heavy masses, because serious accidents happen every little while from the fall of such objects upon the platforms of scaffolds.

Special precautions should be taken to prevent ropes from becoming chafed by rubbing against walls

or other obstacles. The suspension ropes of swinging scaffolds should be kept free from the building, wherever necessary, by methods that will be suggested by the circumstances of the case. Where abrasion is likely to occur in any other way, effective protection should also be provided. Wrapping the rope with burlap or with rags, or applying a pad (sometimes called a "softener") of other soft material to the object against which the rope rubs, will often afford satisfactory protection. Never paint steel stacks, or other similar objects, when they are so hot as to make it possible that the scaffold ropes may be charred or otherwise damaged.

All ropes, slings, and tackle, that are likely to be used for scaffolds or for hoisting, should be inspected with particular care, and when not in use they should be stored in a dry place, under the charge of the foreman or some other specially designated person who should be held responsible for the safe condition of everything of the kind that is given out to the men. Ropes that are considered to be unsafe should be destroyed, to avoid all possibility of using them again by mistake.

See that all knots are securely tied, and wherever practicable lash the ends of the rope with small cord, close to the knot, to prevent untying.

Scaffolds should always be taken down as soon as they have fully served the purpose for which they were erected.

Test all swinging scaffolds that are to be used for painting, cleaning, decorating, and other similar purposes, by the method recommended in paragraph 147, under "*Miscellaneous Scaffolds*".

156. Interference with Scaffolds. Whenever there is even a remote likelihood of a scaffold being *wilfully* disturbed, either by the removal of material from it or in any other way, some one or more specially designated men should be charged with the duty of protecting it and preventing such interference. It is by no means uncommon for some person needing a piece of wood to pull a promising section of it from a scaffold upon which men may be at work; and the piece that is detached is often essential to the safety of the men above, because in building scaffolds it is not customary to put in any considerable amount of unnecessary material. We recall one case in which a man removed a board from a scaffold, without authority to do so, and used it to bridge a gap between the scaffold and an iron beam near by. The board broke while the man was standing upon it, and as he was injured by the fall he brought suit against the contractor who erected the scaffold and endeavored to collect damages to the extent of five hundred dollars.

The person responsible for the safety of the scaffold should see to it, not only that no part of the structure is removed, but also that there is no interference with the scaffold in any way whatsoever. The importance of this advice is well shown by the following experience with a high, fixed scaffold in the very heart of the financial section of New York City, where the travel is heavy and the sidewalk and street are often badly congested. The scaffold was well constructed, and upon it there rested a total load of nearly one hundred tons, consisting of stone, mortar, water barrels, and various other things, in addition to the many workmen. A gang of pipe-fitters on the ground level, wishing to

bend some pipe and not being provided with the proper tools, bored holes through the uprights of the scaffold to hold the ends of the pipe. The bending was then done by forcing the free end of the pipe in a horizontal direction, as though trying to wrap it around the pole. A severe twisting stress was thereby thrown upon the poles, and the holes also became splintered and ragged in a short time, so that it soon became necessary to bore new ones. By this process the scaffold was seriously weakened before the man in charge of it observed what the pipe-fitters were doing, but the danger was fortunately detected before an accident occurred. The damage was repaired, and thereafter a watch was set at the base of the scaffold, to see that nobody tampered with it further.

One more illustration of the danger of interfering with a scaffold may perhaps be given with advantage. In this case a number of men were constructing a gas tank, and three of them were working on a scaffold consisting of a twelve-inch plank resting upon brackets that were fastened to the outside of the tank. There were supposed to be two bolts to each bracket,—one at the top and one at the bottom; but when the scaffold was put up the bottom hole of one of the brackets did not come in line with any of the holes in the outside of the tank, and consequently no bolt was put in at this particular place. At the time of the accident the men were working on the sixth course of the tank, counting from the ground. A gang of riveters, working on the inside of the tank at the same level, started to remove the nut from the single bolt that held up the bracket that was supporting the men on the outside. Somebody called to them and

asked if they were not removing the wrong bolt; but for some reason they continued to take the nut off, and then struck the bolt from the inside with a maul. The scaffold fell immediately. One of the workmen was fatally injured, another had his shoulder dislocated, and a third had two bones broken in his foot and one rib fractured.

In addition to interference consisting in voluntary though rarely malicious acts such as we have described above, there are other ways in which scaffolds may be disturbed with equally disastrous effects, but without intention on the part of any person. For example, a wagon may weaken the pole of a scaffold by backing up against it or colliding with it, or by dumping a heavy mass of material against it; or swinging loads may come into collision with the poles, platforms, suspension cables, or other parts of the scaffold. The results of an accident of this kind are shown in Fig. 127, which shows the remains of a horse scaffold. A slack hoisting rope became accidentally looped under some projecting part of this scaffold, and when the hoisting signal was given the scaffold was immediately reduced to the condition shown in the engraving.

When a scaffold is used at or near a place where hoisting is done, projecting parts of it are likely to be caught or struck by the objects that are being hoisted, or by the hoisting tackle itself. This danger should be constantly remembered, and although it is necessary for the putlogs or bearer-bars of fixed scaffolds to project outward to some extent, the possibility of loads catching upon them should never be forgotten, and the operation should be conducted with corresponding forethought and caution. Special care must

FIG. 127. REMAINS OF A HORSE SCAFFOLD, AFTER IT HAD BEEN FOULED BY A HOISTING CABLE.

also be taken to safeguard scaffolds standing near railroad tracks, roadways, or passageways of any kind where heavy teaming is likely to be done.

It is impossible to discuss all the sources of danger to which scaffolds are subject. Their number is legion, and they are often easy to overlook. In one case that came to our notice, a steel suspension cable accidentally came in contact, high overhead, with a wire conveying electricity at a considerable tension. The chafing that followed rubbed the insulation from the electric wire, and occasional short-circuiting occurred between the conductor and the cable, with the resulting formation of electric arcs that had burned the cable about half off before the danger was detected.

In every case in which there is reason to think that the scaffold may be subject to interference or disturbance of any kind, either intentional or purely accidental, a watchman should be posted at some suitable point to protect the structure against damage and insure its integrity.

157. The Load on the Platform. As we have repeatedly said in the course of this volume, it is of the highest importance, in every form of scaffold, to avoid overloading the platforms. They should not be used for the storage of materials that are either heavy or bulky,—excessive weight being manifestly dangerous by reason of the severe stresses thrown upon the parts, and unreasonable occupation of space by bulky objects being also dangerous by reason of the obstruction that is thereby offered to the free travel of the workmen. Material should never be deposited upon the platforms faster than the needs of the workmen require, and the load should always

be distributed over the platform in a reasonable manner, and not concentrated at a few points.

Helpers should never be allowed to throw bricks, mortar, or other materials, down upon the platform from their shoulders, because the shock transmitted to the scaffold by so doing is likely to lead to a serious accident.

158. Light. Work should be done by daylight only, whenever this is possible. If artificial light must be used, it should be strong enough and penetrating enough to enable the workmen to see easily and distinctly. It should also be diffuse and uniform, and should never be localized in blinding centers of great intensity, with comparatively dark spaces between. Incandescent electric lamps, proper in size and number, properly installed and distributed, and equipped with suitable reflectors, are preferable to arc-lamps, unless the arc-lamps are numerous and are arranged so as to avoid strong, sharp shadows. Arc-lamps that are operated upon alternating-current circuits of low frequency are especially objectionable, because the light that they yield is usually intermittent, with a period equal to that of the electric current itself. This fact is not perceived when the eye is directed steadily toward one object and everything in the field of view is stationary, but it becomes immediately perceptible whenever the object or the eye moves quickly. A swinging hammer, for example, presents a strange appearance, suggestive of the slats of a chicken coop; and the workman, when his eye turns quickly from one direction to another, often experiences a peculiar feeling which is not easily described, but which is akin to dizziness, and tends to make him uncertain on his feet.

Whenever artificial light is used, all ladders, stairways, runways, and other passages should be especially well illuminated. Workmen should be forbidden, under all circumstances, to step upon any part of the structure that is not well lighted, or to visit the workplace in the dark, or to continue at work after the daylight has faded into twilight, unless adequate artificial illumination has been provided.

All electric wires that occur about a scaffold, in connection with lighting or power circuits, should be carefully and thoroughly insulated, and they should be run in strict conformity with all the laws, ordinances, and underwriters' regulations that may be applicable to them. The running of electric wires is a subject that calls for special knowledge and training, and it is easy for an inexperienced man to violate conditions that are essential to safety.

159. Dismantling Scaffolds. The proper methods for taking down suspended scaffolds that are used for construction purposes have been described in paragraphs 109 and 121. Pole scaffolds should be taken down piece by piece, beginning at the top and working downward in such a way as to leave all braces, rails, foot-boards, and other safety features in position until they are no longer needed for the strengthening of the part of the scaffold that remains, or for the protection of the workmen. The men should take special care to avoid falling when dismantling the scaffold, and also to avoid exposure to injury from falling materials. In general, the material that is to be removed should be lowered to the ground on hoists or by rope slings, and not thrown down. It may be permissible, in special cases, to throw down certain

parts of the scaffold, but no workman should do this without special permission from the foreman, nor until he has first made sure that there is no possibility of injury to any person below. It is not enough for the man above to satisfy himself that no person is in sight, because it is quite possible that somebody is in the very act of coming out of a doorway or around a corner or from under a shed, into the zone of danger. To guard against a contingency of this kind the workman above should first look down to see that the region of danger is clear, and he should then utter a warning cry, loudly and distinctly, several seconds before releasing his load. The common habit of calling out at the very instant the mass is thrown is ineffective and dangerous. If any considerable amount of material is to be thrown down in this way, a watchman should be stationed where he can see and control the whole operation. Although it is defensible to throw down certain materials when precautions similar to those here outlined have been taken, we desire to strongly emphasize the fact that it is far safer to lower the materials on hoists or by rope slings *in all cases*, than to throw any of them down; and throwing should never be permitted, under any circumstances whatever, except from very moderate heights. Planks and other wooden parts are often badly damaged by being thrown to the ground from a scaffold, and the practice is therefore costly as well as hazardous.

In separating the various members of the scaffold, care should be taken to avoid splitting the material, or damaging it to an unnecessary extent in other ways, because it may be subsequently needed on another job, and in that case it should be kept in as good a

condition as possible. The use of the implement shown in Fig. 11 is strongly advised, when removing ledgers that have been nailed to the poles.

When a scaffold is broken up, all of its parts should be carefully examined, at once, for projecting nails; and any nails that are found should be drawn out, driven in, or bent over in a workmanlike way so that their points are buried in the wood, and so that they cannot subsequently give rise to injuries in handling the material, nor in stepping or falling upon it. This precaution, though simple and evidently sensible, is commonly neglected, and ledgers, braces, and other parts of scaffolds are allowed to lie about with nails projecting from them, menacing the workmen. Many injuries result, and some of them are followed by blood-poisoning or other forms of infection, with serious consequences.

160. Scaffolds Serving Several Purposes. It often happens that a scaffold is needed in some given place for several successive kinds of work, to be executed by as many different sets or "gangs" of workmen. In finishing the interior of a room, for example, the carpenters and builders may have need of a scaffold, and later, in the same room, the plasterers may need one, and still later the painters and decorators may have occasion to use one. In such cases it is often a fair question whether the same scaffold should be used for all the work that must be done in the given place, or whether a new and wholly different scaffold should be built in each case, by the particular set of men that are to use it.

The problem is somewhat simplified if the work is all done under one contractor, but even in that

case it may not be entirely solved, because the needs of the different gangs of men may be so different that one single scaffold will not serve satisfactorily for them all. A bricklayers' pole scaffold, for example, in which the working platform is shifted to higher and higher levels as the work proceeds, would not be adapted to any subsequent purpose in which constant access to all parts of the wall is important. Furthermore, the foreman of the first gang might not thoroughly understand the needs of the second gang, and hence, even though he were quite willing to build a scaffold that would serve all purposes, he might fail on account of his limited knowledge. It is also possible that he might not even know, when building the scaffold, that it was to be used subsequently for a different purpose; and in such a case it would hardly be fair to shoulder him with a responsibility of which he knew nothing, and which, if he were aware of it, he would perhaps be unwilling to assume.

When two or more independent contractors use the same scaffold in succession, there are many possibilities of misunderstanding and trouble, and even of actual physical danger to the men. In such a case it would not be fair to the first contractor to require him, without special compensation, to go to extra expense in order to build his scaffold so that it would be appropriate to the uses of others besides his own men; nor would it be fair, without such compensation, to require him, after completing his own work and withdrawing his men, to keep the scaffold in repair for his successors. Yet if the structure were allowed to deteriorate, the employees of the second contractor, even though forbidden to do so, might

use it before it had been put in safe condition again, and be thereby exposed to danger.

For these reasons among others, many builders and contractors maintain that as soon as one set of men has finished its own special work, all scaffolding that may have been erected for the furtherance of this work should be pulled down, and that the next set of men who have occasion to do work in this place should build a new scaffold, adapted to their own purposes. This involves a considerable extra expense, and in most cases it should be possible for the various contractors to combine their interests in some way, so that useless expenditure and loss of time would be avoided without sacrificing the interests of any person, and without exposing the workmen to unnecessary danger. If the second contractor needs a heavier and stronger scaffold than the first one, or needs special platforms, or hoistways, or other features that the first one does not use, these could be provided either at the outset or later on,—a fair and amicable agreement being made before beginning the work, with regard to the assessment of the costs.

An arrangement of this kind is likely to be conducive to safety in more ways than one. For example, one of the interested contractors may be a more careful man than another, and in making arrangements for the building of a scaffold to be used in common, the influence of the careful man, although exerted primarily for the protection of his own men, will also tend to increase the safety of all other men who may use the scaffold. Another advantage of having an understanding of this kind is perhaps worthy of mention. If, for example, the scaffold is needed

by the first contractor for the actual performance of work, while the second one needs it merely as a protective precaution or safeguard, there is danger that the second contractor might overlook it, or decline to put it up on account of the expense or the delay that would be involved,—whereas he might be quite willing to pay a reasonable amount for having it left in place, and his men would thereby have the advantage of greater security than they would have had if the separate-scaffold plan were followed.

In any event, when a scaffold that has been erected by one set of men for one purpose is to be subsequently used by another set of men for another purpose, the change should never be permitted until the foreman or superintendent of the second crew has stated, explicitly and preferably before witnesses, that he has carefully examined the scaffold or had it examined by a competent man under his charge, and that he is fully satisfied as to its safety. Furthermore, in case two or more crews of men, who are engaged on different tasks under different contractors, have to make use of the same scaffold *simultaneously*, the foreman of each crew should be required to examine the scaffold and satisfy himself as to its safety and its adaptability to his purposes, before allowing his men to use it. Under all circumstances, too, there should be a definite and unequivocal agreement as to the inspection of the scaffold and the making of necessary repairs, and the responsibility for these matters should be fixed beyond the possibility of misunderstanding or disagreement, whether the various crews of men are to use the scaffold simultaneously or successively.

161. Emergencies. At every place where a scaffold is used under circumstances that might lead to injuries to the workmen, there should be a first-aid outfit, containing supplies sufficient to treat minor injuries. On every large construction job there should also be at least one man who has a thorough knowledge of the proper methods for rendering first-aid to the injured, and he should be supplied with a more extensive outfit. It is important, in rendering first-aid, to remember that it is skill and knowledge that count, and not *good intentions*. A great deal of harm can be done by the well-meaning efforts of an uninstructed person in attempting to give first-aid to an injured man, and unless the service is rendered by a man who has received thorough instruction in the art, it is often better to merely await the arrival of a physician, without attempting to render any aid except to check copious bleeding or to perform artificial respiration. It is always better to do *something*,—even if it is the wrong thing,—rather than to allow the injured man to die from loss of blood or from asphyxiation due to the cessation of his breathing. Whenever a first-aid cabinet is kept at hand, whether it is on a construction job or elsewhere, it should be kept in a dry, accessible place, and its location should be made known to every employee, so that it can be found without a moment of unnecessary delay.

The addresses of several physicians who can be had upon short notice should be posted in some conspicuous place, together with their telephone numbers. If there is a telephone on the job these addresses should be posted close to it, to avoid loss of time in putting in an emergency call. First-aid services should

always be regarded as just what their name implies, and in every case of injury a physician should be consulted as soon as it is practicable to do so.

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